THE ANNUAL REPORT

of the

Northeastern Forest Experiment Station

1949

Including a summary
of work during 1949 and plans for 1950

Northeastern
Forest Experiment Station
Upper Darby, Pa.
V.L. Harper, Director

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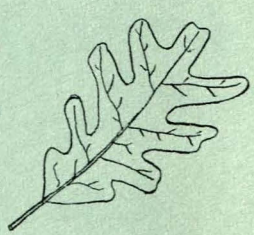

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INTRODUCTION

In reviewing the Station's efforts in the various aspects of forest research in 1949, it seems desirable to highlight some of the basic trends that govern the formulation of forest-research programs. Some of these trends have accelerated during the last 10 years: their impact on current forest-research efforts, and on desirable future forest research, has been felt clearly.

THE CONCEPT OF FORESTRY HAS BROADENED

Students of the subject have long held the view that forestry embraces much more than planting and growing timber, and protecting it from fire. But for a long time this wider concept has had all too little acceptance in everyday affairs. There are many reasons one might advance in explaining this lag, but it is sufficient to point out that the broader concept has now gained wider acceptance. To quote from the Food and Agriculture Organization's Division of Forestry and Forest Products in its comments (in Unasylva 3(6): 1949) on the third world forestry congress held in Finland in 1949:

> "This idea is that the science and techniques of forestry should not be limited to the solution of silvicultural problems as ends in themselves. Closely bound up with 'forests' as a whole, and even with each individual forest, there is a whole set of physical, economic, industrial, and social factors which must be taken into consideration. The

relationship is so close that none of these factors can be considered independent, and together they form a new and broadened concept of the term 'forestry'."

Two examples cited by FAO's forestry and forest products staff as evidence of this broader concept were concerned with (1) the interrelationship between forest and soil conservation and the mutual interest of agricultural and forestry agencies in the conservation and regulation of water flow, and (2) the recognition on the part of both the forester and the businessman that forest-management methods must be aimed at producing the kinds of forest products needed by industry; and that technical research and industrial development must be aimed more squarely at adjustments of "conversion methods and uses to the limitations and requirements of sound silviculture".

These are good examples, and they are clearly in evidence in the northeastern United States as well as elsewhere. Northeastern surveys and research work have undoubtedly done much to focus attention on the important role of forests in the general economy of the region. Certainly the impact of a wider interest in the practice of forestry has been felt in the demands being made on northeastern forest research agencies.

DEMAND FOR TECHNICAL KNOW-HOW HAS INCREASED

The final arrival of a long-threatened water shortage in New York city and northern New Jersey has done much to direct public attention to regulation of streamflow, ground-water replenishment, and the relationship between forest and open farmland practices and water control, including sedimentation that often destroys the usefulness of costly reservoirs and dams. As a result, increased interest has greeted the Station's work on flood-control surveys and in watershed management research.

For example, it has been found that humus or ground cover is an important element in watershed management. Where the humus is well-developed, as under a good stand of timber, freezing of the soil is not serious. It freezes in a porous way, like a sponge, and water can percolate into it even though it is frozen. But where the soil is not protected by some sort of humus or cover, it freezes hard as a concrete pavement. Water cannot percolate into it; so it must run off the surface. This increases the flood hazard in one season and the water shortage in another.

Control and conservation of water is sure to demand more attention in the future because the Northeast--highly industrialized as it is and containing large metropolitan areas--requires reliable water supplies. Forestry and agricultural practices will have to be made consistent with good watershed use and management. And this puts a special obligation on Federal and nonfederal agencies to develop the know-how as rapidly as possible.

The growing scarcity of good-quality veneer and sawlogs and the ever-tightening softwood supply of pulpwood for northeastern wood-using industries have imposed another set of critical problems. Quite clearly, northeastern forests could be better managed so they would grow more of the kinds of wood needed by industries. And this would be much easier if it were not for the aggressive, low-grade hardwoods that have already usurped much of the forest land. Two major research and development jobs are to adjust industry conversion practices to an expanded use of such hardwoods and to find practical methods of silviculture that maintain softwoods in the stands. The solution of these problems requires an integrated attack from many angles. The job goes far beyond consideration of silvicultural and utilization techniques alone. Among other things, attention must be paid to forest soils, humus formation, and watershed values; to forest insects and diseases; to better grading and marketing methods for forest products; to taxation of the forest crop; and to the practicality of remedial measures--that is, to costs and returns.

Despite progress already made on these complicated and involved problems, much remains to be done. This is driven home by the increasing appreciation of the role of forests in the total economy and the resultant demand for more intensified effort to develop the forestry know-how. As yet, research agencies have barely begun to develop all the new and improved practices needed to make northeastern forests a growing and vigorous natural-resource asset.

FOREST RESEARCH HAS BEEN EXPANDED

To meet this increased demand the research programs of both Federal and nonfederal agencies have been stepped up considerably in the last 10 years. During fiscal year 1940 the combined Forest Service and nonfederal agency expenditures in the Northeast were about $420 thousand. In fiscal year 1949 the combined total for forest research was about 1.2 million. Even after allowance for the material decrease in the purchasing power of the dollar, one must conclude that the total forest-research effort has been increased substantially.

In spite of this expansion of forest-research activities there are many problems in the northeast that the Federal and nonfederal forest-research programs have not yet reached. It is of interest, therefore, to examine in more detail the size and character of the 1949 programs.

The Forest Service (through its Northeastern Forest Experiment Station) expended during 1949 the sum of $448,709 on research--in the fields of forest and watershed management ($278,769), forest-resource surveys and economics ($148,440), and forest products ($21,500). In addition it carried on some special projects for the Department of Agriculture, such as participation with other bureaus in flood-control surveys and in research on marketing of forest products. Expenditures on these activities are not included in the above figures.

In addition, the forest research effort--measured in terms of the amount of money expended for such activity in 1949--of all state and private agencies in the Northeast amounted to more than three quarters of a million dollars. Of this total the agricultural experiment stations contributed 18 percent. Other state agencies, principally the forestry organizations and the forest schools not connected with Agricultural experiment stations, expended 30 percent. Private institutions and colleges expended 30 percent. The remaining 22 percent of the total expenditure was made by industrial corporations and other private agencies.

It is thus evident that the forest-research job is being shared by all the principal interests that have a major responsibility for it.

Moreover, in this total effort there is a high degree of cooperation among the participating agencies. A study made in 1949 for the Station's Advisory Committee on the Coordination of Forest Research undertook, not only to find out how much money was being expended on forest research in the Northeast by nonfederal agencies, but also to determine the relationship of the nonfederal forest-research effort to the forest-research program of the Forest Service.[1]

Three degrees of relationship were recognized. The first of these includes the "cooperative" projects in which there is a close partnership between the Forest Service and the participating nonfederal agency. In many cases this involves joint approval of working plans and finished reports. In other cases the nonfederal agency provides research installations and materials, office space and equipment, or personnel services for work that is supervised by the Northeastern Station.

The second relationship includes those projects that are "correlated" with the Forest Service research program. Normally this involves mutual interchange of information on what the Forest Service and the nonfederal agency are each doing in the field of a specific research project. There is often interchange of considerable technical data. The nonfederal agency, however, maintains full responsibility for deciding upon its own working methods and for evaluating results.

The third relationship includes all those research projects that are carried on entirely independent of the Forest Service research program. The data on independent research carried on by private agencies in the field of forest-products research are missing because it was not possible to obtain such information on a regional basis.

Breaking down the state and private forest-research expenditures according to their relationship to the Northeastern Station program, it

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[1] More specifically, to the Northeastern Forest Experiment Station.

was found that 26 percent went into cooperative projects, 24 percent was spent on research that was correlated with the Forest Service research program, 50 percent was spent on work that was entirely independent (table 1).

In the field of forest-management research there was a total state and private expenditure of $561,580. Of this total 22 percent was on cooperative projects and 23 percent was on correlated work. The other 55 percent went for independent projects. In addition to this annual expenditure, however, state and private agencies made available to the Forest Service for research purposes, forest lands with standing timber and other facilities having a total capital value of $471,320. All of this was provided rental-free. It therefore represents a substantial and continuing contribution to the Northeastern Station's effort.

In the field of forest-resource investigations (principally forest survey), there was a total state and private expenditure of funds amounting to $115,470. Of this amount 48 percent was for cooperative work. The states contributed the bulk of it. An additional 18 percent was expended on correlated work. The remaining 34 percent was for independent forest-resource and forest-economics research work. In addition to the $55,595 actually expended by state and private agencies during fiscal year 1949 on cooperative work, these agencies (principally the states) had already contracted or obligated an additional $265,110 for aerial photos etc. (for use on the Forest survey), which had not yet been purchased and used. Counting in the obligations as well as expenditures, the state and private cooperative contributions to the Station's forest survey amounted to no less than 84 percent of the total expenditures and obligations during 1949.

Lack of data on a regional basis on expenditures for forest-products research made it impossible to make a similar analysis for the Northeast in this field. (The Forest Service has estimated that, on a national basis, the agricultural experiment stations expended on forest products research in 1949 about $0.24 million; other state agencies $1.58 million; private institutions and colleges, $2.14 million; and industrial corporations about $4.69 million. The Forest Service itself spent $1.18 million for forest-products research in 1949, chiefly at its Forest Products Laboratory at Madison, Wis. The state and private nation-wide expenditure for forest-products research totals $8.65 million, of which some 35 percent was spent on projects carried on cooperatively or in correlation with the Forest Service. The total figure of $8.65 million is exclusive of a much larger sum ($43 million) estimated as spent by industrial corporations on the development of trade-secret processes and products.)

This collaboration between the Forest Service and state and private agencies on forest research in the Northeast is formalized in 114 working agreements. These range all the way from rather elaborate legal documents granting the use of lands for experimental forests to simple exchanges of correspondence. Of these agreements, 56 have to do with

Table 1.--EXPENDITURES FOR FOREST RESEARCH IN THE NORTHEAST BY STATE AND PRIVATE AGENCIES, FISCAL YEAR 1949

Field and relationship to Forest Service research program	Agricultural experiment stations	Other state agencies	Private institutions & colleges	Industrial corporations & other private agencies	Total state & private
Forest & watershed management					
Cooperative	$ 10,770	$ 38,550	$ 49,450	$ 22,197	$ 120,967
Correlated	16,000	40,050	10,000	65,835	131,885
Independent	66,954	52,174	127,100	62,500	308,728
Total	93,724	130,774	186,550	150,532	561,580
Forest products					
Cooperative	4,200	9,400	600	5,600	19,800
Correlated	1,800	17,400	10,000	1,000	30,200
Independent	29,593	(1/)	(1/)	(1/)	29,593
Total	35,593	26,800	10,600	6,600	79,593
Forest resources investigations					
Cooperative	--	47,860	3,335	4,400	55,595
Correlated	--	15,000	6,000	--	21,000
Independent	4,550	9,000	25,325	--	38,875
Total	4,550	71,860	34,660	4,400	115,470
All forest research					
Cooperative	14,970	95,810	53,385	32,197	196,362
Correlated	17,800	72,450	26,000	66,835	183,085
Independent	101,097	61,174	152,425	62,500	377,196
Total	$ 133,867	$ 229,434	$ 231,810	$ 161,532	$ 756,643

1/ Data not available on a regional basis. On a nation-wide basis, all state and private agencies expended a total of about $8,653,326 on forest-products research in 1949. Some 35 percent of it was spent on projects carried on cooperatively or in correlation with the Forest Service. A much larger sum (about $43 million) was spent by industrial corporations on the development of trade-secret processes and products. The total Forest Service expenditure on Forest products research was $1.18 million, mainly at its national Forest Products Laboratory.

forest- and watershed-management research, 31 pertain to forest-resource surveys and investigations, and 27 are in the field of forest-products research.

The agricultural experiment stations are a party to 11 of these agreements, 55 are with other state agencies. Private institutions and colleges are involved in 12. The other 36 are with industrial corporations and other private agencies.

TOTAL FOREST RESEARCH SHOULD BE DOUBLED

In spite of the rapid expansion of forest research during the last 10 years there seems to be a clear need for further strengthening of the total effort. In such expansion all agencies have a responsibility and a role to play.

From a nation-wide viewpoint, the Federal Government naturally has a responsibility, because of its 414 million-acre holdings of Federal forests, range, and watershed lands. This represents one-third of the total national area of such lands. So widespread is this public property that it represents practically all of the regional forest and range types. And, the headwaters of most interstate watersheds are on Federal lands. The states also have a responsibility because of their holdings of forest and watershed lands and of the public benefits that come from wise use and good management of all forest and range lands.

The influence of a watershed is felt some distance downstream as well as locally. The management of watersheds in West Virginia is of great interest to people not only of West Virginia, but also in Pennsylvania, and many other states at the lower reaches of streams flowing from West Virginia watersheds. The proper management of the Delaware River watershed is of tremendous concern to people of Pennsylvania, New York, New Jersey, and Delaware. The recent water shortages in New York City and in northern New Jersey have done much to emphasize this. Similar interstate watershed relationships exist throughout the United States. Strong Federal and nonfederal participation in research on a cooperative or correlated basis is essential in bringing about a fully integrated watershed-research program.

Private ownership of lands important for production of renewable natural resources--i.e. lands exclusive of the noncommercial areas that may grow little or no timber and forage but that, along with many commercial forest and range lands, are important as watersheds--amounts to two-thirds of the total national area. It is largely in the hands of small owners. About 4,200,000 small ownerships comprise 76 percent of the private commercial forest lands. Also, about half the forest products are processed by small operators. The small industries are almost wholly dependent upon the 4 million small owners for raw material, and the large industries also depend partly upon them.

These small owners and operators are not able to finance intensive and long-term research on their own. Certainly there is a joint Federal-State responsibility to see that the benefits of scientific advancement are not denied to this important sector of the country's economy.

The annual timber harvest of the Northeast, on the stump before any additional values are added, amounts to at least $50 million. Many of the large and progressive private business enterprises devote as much as 3 percent of their gross receipts to research. It would therefore do no violence to recognized sound business principles, to devote at least a million and a half dollars annually to forest-management research in the Northeast. Industrial corporations and other private agencies are now spending about $150,000 annually on forest-management research. Their efforts might readily be increased. Private enterprise has an even more direct interest in forest-products research. A similar allocation to research from the value added by the harvesting and processing of timber products in the Northeast would run into real money--3 percent on at least $300 million or $9 million. Data on just how much money is being spent by regions on forest-products research by private enterprise are not available. It is certainly short of this level.

How much should the total forest-research effort be strengthened? A reasonable national goal, say to be reached within the next 5 years, would appear to be a doubling of forest research effort. Not nececessarily a doubling of 1949 effort in every state and region nor in every research activity, but a doubling of the over-all effort.

In 1949 the Federal Government expended, nation-wide about $5.0 million on forest research. The state agencies expended $4.0 million. Together, they spent $9.0 million, much of it in close collaboration on projects.

How does this compare with agricultural research, not including forests? In 1949 the Federal Government spent, nation-wide, more than $50 million on such research; the states spend more than $40 million. Together they spent more than $90 million. Thoughtful people will agree that the research on agricultural problems has been a very good investment. It has brought forth many labor-saving devices and improved farming methods, improved animals and improved plants; in the aggregate these have made it possible to provide food and fiber for the entire United States through the farming efforts of less than 15 percent of its population. Contrast this with some other countries such as China, which still expends more than three-fourths of its total energy just to produce food and fiber.

Thoughtful people will also agree that the end is not in sight for further improvement in agricultural methods and products. Not only must the current agricultural research effort be maintained, but in many respects it, too, needs strengthening.

But are forestry methods and forest products worth in terms of research effort only one-tenth of what open farm-land methods and products are worth? It seems fair to assert that forest research is relatively more important than the amount of effort now devoted to it indicates.

The real justification, however, for strengthening forest research all along the line is in the magnitude of the job yet to be done. The national, state, and local need is great for improving the scientific basis for managing and utilizing a vast, renewable resource that provides timber, water and other products and services so essential to a strong and healthy economy. This is the conviction that drives the Northeastern Station to maximum efforts. It is the conviction that causes all northeastern agencies, Federal and nonfederal, to display a commendable teamwork in attacking the region's forest problems. It is the conviction that will cause all northeastern agencies to further strengthen forest-research effort wherever possible and as rapidly as possible.

THE WORK OF THE STATION DURING 1949

The pages that follow describe the varied activities of the Station in the technical fields of forest genetics, forest management, forest influences, flood-control surveys, forest-resource surveys, forest economics, forest utilization. Activities in forest entomology and forest pathology research, carried on by other bureaus of the Department of Agriculture in collaboration with the Station, are also reviewed.

FOREST GENETICS

a basic field of study in forest management

It has been said that genetics, the science of the quality of life as it passes from generation to generation, is in many respects the greatest and youngest of all the sciences. Certainly, it is one of the most important of the basic sciences; for what is there more important than exact knowledge of the continuity of life? Every living organism is a continuing part of the germ plasm of its ancestors, and development and behavior is basically influenced by this hereditary material.

The expansion of forestry activity in recent years has brought home more than ever the realization that our basic knowledge of the foresters' "stock-in-trade," forest trees, is very limited. Little is known of inheritance in our native trees, of their races and strains, or of the inherent adaptability of exotic species and races.

Forest genetics, in its application to practical forestry, has two broad functions, both of which will require the accumulation and interpretation of sound information on heredity and variation in forest trees. Briefly stated, these are: (1) production of improved forest trees for reforestation; and, (2) genetic improvement of our native forest stands that are managed under a system of natural regeneration.

With long experience and close observation, the practical forester, like the practical farmer, can accomplish much; but without exact knowledge of inheritance derived from basic genetics research on trees, maximum improvement of our forests will not be reached, progress will be slowed and mistakes will be numerous. Basic inheritance studies require considerable time for their completion and for this reason they cannot be postponed until the results are needed for application in intensive forest-management practices.

Nor can long term projects such as these be expected always to provide new and startling results annually. But each year we do have some important results, not necessarily because they are final but because they indicate significant possibilities in new and unexplored directions. Such items worthy of mention may be new discoveries, or they may be applications of earlier basic research results to situations and needs that have arisen recently.

FIELD TESTS WITH HYBRID POPLARS IN 1949

Many of the hybrid poplars tested in plantations for the first time during 1949 have made an excellent first-year showing. In their early years, at least, hybrid poplars are extremely sensitive to many site factors, particularly to inhibition by grass and weeds, which often encroach in spite of cultivation, and to insufficient or excessive soil moisture. For this reason there is often wide variation between the average growth on different test plots in the same locality, and under such conditions the average growth on the best single test plot approaches more closely the true measure of maximum inherent vigor.

The 1949 clonal tests indicate that we have many hybrids that are inherently fast growers. In tests at the Hopkins Experimental Forest, Williamstown, Massachusetts, where 4-foot growth from dormant, unrooted cuttings in the first year represents very good inherent vigor, 51 hybrids were above this height and 13 outstanding hybrids averaged between 5 and 6 feet. At the Beltsville Experimental Forest in Maryland, where the mark for very good inherent vigor should be raised to 6 feet, 58 hybrids passed this mark. Four of the hybrids in this test grew to an average height between 8 and 9.5 feet in one year from unrooted cuttings.

With such a large number of vigorous hybrids, representing a wide diversity of parental types, available for field tests, the possibilities are excellent for ultimately uncovering many that not only grow rapidly but also resist disease and insects.

COVER CROPS FOR HYBRID POPLAR PLANTATIONS

For successful establishment, hybrid poplar plantations must be kept reasonably free of weeds and grass during the first growing season. During the past year we started a search for a cover crop that would keep down grass and weeds and yet would have no inhibiting effect on the planted poplars. In other words, we are looking for a cover crop that can be grown with poplars to eliminate the need for cultivation; this is essential if hybrid poplars are to be grown on land where cultivation is impractical or impossible. Eleven different cover crops were tested in a pot experiment at the Beltsville Experimental Forest. In this experiment, Korean lespedesia did not inhibit the growth of poplars even though it was sown so densely that grass and weeds were eliminated. Buckwheat, though very shallow rooted, had the most serious effect on the poplars, 40 percent reduction in growth. Apparently some plants that grow vigorously and aggressively enough to eliminate grass and weeds can be grown in association with hybrid poplars. With the need for weeding eliminated by a suitable cover plant, the usefulness of hybrid poplar will be tremendously expanded, and the prospects, from this preliminary experiment, are highly promising.

BREEDING

Birch Breeding

During the past year it has become increasingly apparent that our earlier breeding with birch can provide a sound basis for any work aimed at producing an improved birch to replace the native white or paper birch which is now rapidly dying off throughout its range. Previous to 1942 we made many birch crosses, among them hybrids between paper birch and gray birch. These hybrids are intermediate in growth rate between the parent species, that is, they grow faster than paper birch, but not quite so fast as gray birch. Although the female parent was gray birch, the hybrids resemble a good type of paper birch in all outward appearances.

Our previous birch breeding work also showed that crossing selected white birches, and hybridization of white and gray birch, could be carried out on a mass-production scale. Now, as the need becomes more and more apparent, the groundwork is available for a comprehensive breeding program to produce a white birch that is resistant to "die-back."

Tree Breeding During 1949

The breeding work, in cooperation with the Morris Arboretum of the University of Pennsylvania, produced eight apparently successful hybridizations between maple species and three crosses between species of ash. Many additional hybridizations failed, some apparently due to factors which can be eliminated in future work. Crosses between races of yellow-poplar again produced large numbers of seeds. Seedlings from such crosses in 1948 are now growing in the nursery but are still too young to provide definite information on the possibility of hybrid vigor.

Producing a spruce that is resistant to budworm (for planting in areas subject to periodic budworm infestation) is a problem of considerable importance in the Northeast. The fact that poplar hybrids actually vary from practical immunity to complete susceptibility to defoliation by Japanese beetle, justifies an attempt to hybridize spruce species for insect resistance. Ten different crosses between species of spruce produced seed in 1948 but only one of these seedlots germinated. The one-year-old seedlings have the earmarks of hybrids.

EFFECTIVE POLLINATION DISTANCES

Natural regeneration of a forest stand under any system of management depends upon an adequate supply of viable seed, and this in turn depends upon pollination. Observation and research during 1949 has thrown considerable additional light on the relation of tree spacing to wind pollination.

Pollen counts made at varying distances from heavily pollinating trees corroborate observations on fruitfulness of isolated trees. Species of spruce, fir, oak, and pine have yielded little viable seed except where other trees of the same species were growing close by. It is apparent that air-borne pollen of many of these species travels only short distances in quantity, and that distances on the order of only a few hundred feet may be the limiting factor in viable seed production. For eastern white pine in the vicinity of Philadelphia, viable seed production was only 0.3 to 1.8 seeds per cone on trees isolated from pollinating trees by 200 feet or more.

This isolation by distance is of great importance in the management of white pine forests of the Northeast, because it indicates that distances as short as 100 feet between seed trees may reduce effective pollination below the requirements for effective seed production.

Production Of Empty Cones Or Seeds

The 1949 breeding work has further confirmed our observations on parthenocarpy (production of fruit without normal pollination) in eastern white pine, some maples, firs, yellow-poplar and spruce. Cones or fruits of normal size are matured but without seed or with empty seeds. Thus, the number of cones or the size of the fruit crop on forest trees which may be isolated at distances sufficient to prevent pollination, is no indication whatever of a good seed crop.

CURRENT EMPHASIS IN FOREST GENETICS IS ON DEVELOPMENT OF FAST-GROWING AND DISEASE-RESISTANT HYBRID POPLARS

The headquarters for the forest genetics studies are in Upper Darby, where Dr. Ernst J. Schreiner, station staff geneticist, can give over-all direction and supervision to work under way throughout the Northeast. The breeding work is concentrated at the Morris Arboretum at Chestnut Hill, Pa., under cooperative arrangements with the University of Pennsylvania. The genetics nursery work is concentrated at the Beltsville Experimental Forest. Field tests of poplar hybrids and other stock are carried on at most of the Station's experimental forests and elsewhere.

The Station's forest genetics work deals chiefly with hardwoods of the United States. In this respect it complements work under way at the California Forest Experiment Station, which is chiefly on the pines.

Current emphasis in the Northeastern Station's genetics research is on the production and testing of hybrid poplars that show promise of being both fast-growing and disease-resistant. The Division of Pathology of the Department of Agriculture's Bureau of Plant Industry, Soils and Agricultural Engineering is cooperating by studying the diseases of the hybrids.

SUMMARY OF FOREST GENETICS WORK DURING 1949

Breeding

1. Propagated seedlings of hybrid origin (interracial and interspecific) in maple, oak, spruce, and pine derived from the 1948 breeding work.

2. Produced seed from controlled pollination between races and species of maple, ash, yellow-poplar, spruce, and pine, and in many cases determined the approximate viability of the seed lots.

Field Tests

1. Selected 44 additional hybrids from the 21-year old seedling plantations in Maine for propagation and systematic testing in the Northeast.

2. Established uniform crop-tree and sapling clonal tests of hybrid poplars at the Beltsville and Hopkins Experimental Forests.

3. Made detailed examinations of 1948 and 1949 hybrid poplar clonal field tests for disease and insect damage and found no serious conditions.

4. Remeasured hybrid pine plantations in New Jersey and summarized the data.

Physiology

1. Demonstrated that parthenocarpy (production of fruits lacking good seed) is widespread in forest trees.

2. Showed that isolation of eastern white pine trees by distances of a few hundred feet may reduce pollination greatly and thus cause unfruitfulness or scant seed production.

Racial Variations

1. Grew seedlings of white and green ash of various geographic origins collected earlier.

2. Arranged for and received new lots of seed of white and green ash from areas not previously represented in the racial stock being grown.

3. Propagated seedlings of many desirable exotics from seed of known origin.

PLANS FOR FOREST-GENETICS WORK IN 1950

1. Prepare plans and instructions in Upper Darby for work on hybrid-poplar tests and other forest genetics work to be carried out by personnel at the Station's various experimental forests.

2. Establish additional stool planting at the Beltsville Nursery, of newly selected hybrid poplars.

3. Establish crop-tree and sapling clonal tests of additional poplar hybrids at the Beltsville, Hopkins, and Massabesic Experimental Forests.

4. Establish field experiments to test the possibility of using cover crops in hybrid poplar plantations (to keep out inhibiting grass and weeds, and thus eliminate the need for cultivation), at Beltsville, Hopkins, and Massabesic Experimental Forests.

5. Continue cooperation with the Division of Forest Pathology of the Bureau of Plant Industry on diseases of hybrid poplar.

6. Carry out hybridization work at Morris Arboretum with maples, ash, birch, spruce and fir, using specimen trees in the Philadelphia area which bloom this year, of species not previously crossed. Racial hybridization with maple, ash, and yellow-poplar.

7. Propagate seed derived from 1948 controlled breeding in the greenhouse and nursery at the Morris Arboretum.

8. Continue observations and study on genetics plantations of pedigreed progenies at the various experimental forests and elsewhere in the Northeast.

9. Sow seed of white and green ash from various geographic sources received in the fall of 1949, in the Beltsville nursery.

10. Sow hybrid pine seed, to be received from the California Station, in the Beltsville nursery for cooperative field tests in the Northeast.

CUTTING PRACTICES
and other aspects of forest management

In the Station's annual report for 1948, a set of principles and criteria were presented for five intensities of cutting practice, ranging from high order to destructive. During the past year these principles and criteria were applied and tested in regional forest types--white pine, mountain hardwoods, Virginia pine, and Anthracite Region hardwoods. This was done on a series of plots established on the Massabesic, Fernow, Beltsville, and Pocono Experimental Forests. The plots contain about 5 acres each, large enough to present a realistic picture of the various levels of forestry that these cutting practices represent. Four intensities of cutting practice (high order, good, fair, and poor) were applied.

The 1948 report brought out also the need for studies to determine the conditions for which the several levels of cutting practice are appropriate silviculturally and profitable financially. To this end, large-scale (pilot-plant) experiments were set up on the Massabesic, Pocono, and Fernow Experimental Forests during 1949. These experiments and tests will be conducted on compartments ranging in size from 20 to more than 100 acres each; they will occupy about 1,000 acres at each forest. The experimental cuttings and other treatments thus approach commercial or industrial size, with costs and returns indicative of those of forest owners and operators. In addition, these experiments are expected to provide comparisons of the costs and returns from growing saw timber as against other products, at different stand densities and with different volumes of growing stock.

COMPARTMENT-SIZE EXPERIMENTS

Much has been said and written about the long-range viewpoint in forestry and about the effect of interest rates and investment in controlling what is or may be practiced. These are points toward which the pilot-plant compartment studies are directed. And since we are interested in cumulative silvicultural effects and periodicity of income and expense, the tests are designed to continue for an appropriate period of years. To assure comparability between experimental forests as well as among the compartments within an experimental forest, a uniform system of records is employed at all the Station's experimental forests.

The general plan and objectives of the compartment pilot-plant studies established this past year will be used in planning similar tests

on four other experimental forests in 1950. Those at the Beltsville Experimental Forest will deal with the coastal and Piedmont oak-pine type, at the Penobscot with spruce-fir, at the Paul Smith with Adirondack spruce-fir-hardwoods mixtures, and at the Bartlett Experimental Forest with northern hardwoods.

The larger-scale, pilot-plant experiments are a major (and badly needed) development in forest-management research, a necessary supplement to the traditional small-plot pattern of forest research. These larger-scale manipulations of forest cover are practical tests; through them many gaps in our knowledge of silviculture and watershed protection are being disclosed. Furthermore, the extent and duration of harvest and cultural operations on the compartments will add realism to figures on man-hours and machine-hours and other costs. They are the kind of data that forest owners and operators can apply to their own policies and properties.

MOWING NORTHERN HARDWOOD REPRODUCTION IS TOO EXPENSIVE

Many of the small-plot studies have already indicated how costs can be reduced, useless operations avoided, or better growth and returns obtained. Such a study was made on the Green Mountain National Forest: its purpose was to test the effectiveness of mowing northern hardwood reproduction immediately after a harvest cut--with the hope that the composition, density, and form of the succeeding reproduction would be improved. Three 5-acre plots were logged for saw timber during the winter of 1933-34. On one plot nothing further was done. On the other two all unmerchantable large trees were girdled and the saplings were cut off with an ax. On one of these two, in addition, all the remaining reproduction was mowed off with a scythe.

Fifteen years later, in 1949, it was apparent that girdling unmerchantable holdovers is a good investment, but that mowing advance reproduction is a poor one. Where no extra work was done, only 39 percent of the milacres have reproduction of timber species with stems 0.6 inches or larger. Where large culls were girdled and large saplings cut, 75 percent of the milacres now have timber species well established. Mowing increased this percentage only to 78. Moreover, the average diameter of reproduction on mowed and untreated areas is slightly smaller than where only girdling and cutting of large saplings was done. On the untreated check plot, beech is more prominent than sugar maple and yellow birch, but this situation is reversed on the two plots where the cultural measures were used. Then too, on the check plot only about 500 potential crop trees per acre have a fair to good form, whereas there are about 1,300 per acre on the girdled plot, ample for a new stand. Where mowing was done as well as girdling, there are now about 1,700 potential crop trees of fair to good form.

Mowing is expensive. It requires from 9 to 13 man-hours per acre. And on these plots the results just weren't worth the cost.

USE OF POISONS IN STAND-IMPROVEMENT SHOWS PROMISE

Of course girdling has long been known to be an effective way to kill unwanted trees, but a surer, quicker, and cheaper method would probably lead to improvement of the growing stock and regeneration on thousands of acres. The answer seems to lie in the use of poisons.

Use of a power tree-tapper developed for the maple-sugar industry promises to provide the needed mechanization. Tests at the Paul Smith Experimental Forest indicate that undesirable holdover trees can be killed for $2 to $4 per acre. In the tests, poisons were placed in relatively small holes bored roughly parallel with the bark. The bit for the boring is driven by a flexible shaft connected with a 1-horsepower gasoline engine mounted on a pack board. Sodium arsenite, a proven tree killer, as well as a poison deadly to animals, was put in the holes as a 50 percent solution. It kills the trees quickly if the holes are spaced 8 inches or less apart. Two men can poison about 40 large trees per hour. The poison kills 80 to 90 percent of the trees.

But a less dangerous poison is needed, even though the small hole used seems to guard against the poisoning of deer and other animals that are attracted by the taste of the sodium arsenite. Ammate (ammonium sulfamate) meets this requirement, but in the Paul Smith tests it did not kill trees as quickly as sodium arsenite did. From previous work on other species, however, it is known that the full effect of Ammate may not show up until the second year. Observations in 1950 will disclose whether that is true for the northern hardwoods being studied on the Paul Smith Experimental Forest. If so, it will provide a practical answer to the problem of how to reclaim for usable production tens of thousands of acres now dominated by trees that are steadily losing instead of gaining value.

PARTIAL CUTTING FOR NORTHERN HARDWOODS PLUS PLOWING BACK A PORTION OF STUMPAGE RECEIPTS

Light partial harvest cuts have yielded good results in northern hardwoods, yet the tenth year remeasurement of a series of plots on the Finch Pruyn Experimental Forest in New York shows that they must be applied with skill or their purpose will be defeated. In the 10 years since a partial cutting reduced the basal area of a beech-birch-maple stand from 110 square feet to 78 square feet, the stand has grown 23 square feet in basal area. That is fair growth; but study of the stand reveals that much of it may never be useful and may prevent the growing of quality material.

In the Adirondacks, beech is generally a poor species. It has bad form, low quality, and is subject to frost cracks that provide entrance for heartrot. In the plots under study beech was prominent in the understory; it promptly took advantage of the growing space afforded by the partial cut. Although beech was cut more heavily than the hard maple and

birch, the number of beech stems 3 inches and larger in diameter increased 50 percent in 11 years. And of the 23 square feet of basal area growth made by the residual stand, 12 were of beech. Hard maple accounted for 6 square feet and yellow birch for 5 square feet.

Even more important than the changes in composition is the large proportion of poor quality trees in all these species. In 1949, 52 percent of the trees 3 inches and larger were considered as unmerchantable or incapable of growing into merchantable trees. By species, 68 percent of the growth of beech was in worthless trees, 40 percent of that of the hard maple, and 25 percent of the growth of yellow birch. For the stand as a whole, 12.6 square feet, slightly over half the growth, was made by trees that should come out of the stand.

But, if partial cuttings fail to provide a quick and easy single treatment for putting Adirondack hardwood stands in excellent condition, they do suggest a program for steady improvement. Frequent cuts that remove poor growing stock, by girdling or poisoning if necessary, along with some merchantable trees, seems now to be the only solution. In making such cuts, the owner necessarily would have to forego some immediate cash return and "plow back" some into the cultivation of his next crop. To what extent any individual owner can do so will depend upon when he wants to get an income from his timber as well as on his general financial situation. This we know: continuance of past and present cutting practices will drain away the assets of the hardwood type, and will leave only the liabilities.

REHABILITATION OF SCRUB-OAK AREAS IS DIFFICULT PROBLEM

How to reclaim for tree growth vast areas of land occupied by scrub oak (in Pennsylvania and other states) moved a little closer to solution during the year. Literally millions of acres of land capable of growing a third, and perhaps a half, of a cord of usable wood per acre per year have been taken over by scrub oak. Incapable of producing wood for any use, a poor game food, and of doubtful value for watershed protection, dense scrub oak has successfully resisted previous efforts at interplanting.

The key to the problem seemed to lie in clearing the scrub oak from an area large enough so that planted trees can grow above the brush before it closes over; and to clear such spots at a reasonable cost. Hand work and ordinary plows failed because of the dense mat of roots and the rocky soil.

A crawler tractor (70-horsepower class) equipped with an angle-dozer tilted to cut a wide, shallow furrow gives promise of doing the job. It rips the root mat from a furrow 3 to 4 feet wide and 6 to 8 inches deep. Spacing furrows 8 feet apart, preparation for planting costs about $10.00 per acre (tractor and driver costs figured at $9.00

per hour). Using a tractor of the 35-horsepower class, costs were higher because it did not have enough power to make steady progress.

Efforts to devise still cheaper methods for site preparation are continuing, because an over-all investment of perhaps $20,000,000 to prepare the 2½ million acres of scrub oak land for planting is a staggering sum. Possibilities lie in the use of specially designed dozer blades or plows, job organization, and the use of tractors in the 40 to 60-horsepower class with the improved dozers.

Furrowing is, of course, a threat to watershed values; so the search for lower site-preparation costs is following another direction also, and one that may overcome this bad feature of the mechanical method. Plant poisons not toxic to animals are being tested on the Delaware-Lehigh Experimental Forest as a means of killing back the scrub oak on strips without disturbing the duff and root mat. Jeep-mounted, swath-spraying equipment was used to apply various concentrations of 2-4-D and 2-4-5-T in several carriers. Results will not be available until 1950, yet the method of application looks promising. For treating rough terrain and large brush, the spray equipment could be mounted on a crawler tractor.

SOME SIGNIFICANT FINDINGS IN SPRUCE BUDWORM STUDIES

The soundness of the silvicultural approach to the problem of increasing the ability of spruce-fir stands to withstand attacks of the spruce budworm was borne out by the 1949 examination of plots established by the Station in 1945 in the headwaters of the Gatineau River in Quebec. The plots, heavily infested with budworm when they were established, were selected to anticipate conditions expected to prevail when the budworm spread to the United States. Some 400 acres were cut over to increase the stand's resistance to the attack. The favored host, balsam fir, was cut heavily and vigorous, fast growing young balsam, together with a high proportion of the less favored host, spruce, were left. The trees left were vigorous specimens in a wide range of diameter classes.

After 6 years of heavy defoliation, more than two-thirds of the balsam fir trees appear dead to casual inspection and the stand appears devastated. Closer inspection revealed, however, that only 27 percent of the trees have died. Although more will undoubtedly die, the pattern of mortality to date probably gives a forecast of the kinds of trees likely to succumb.

Losses are concentrated in balsam fir trees of small size, low vigor, short crowns, and growing in the open. Only 18 percent of the firs 4 inches d.b.h. and larger have died as against 31 percent of the smaller ones. By vigor classes, mortality has been 11 percent in the most vigorous trees, 18 percent in those of medium vigor, and 27 percent in the poorest vigor class. None of the trees with crowns extending 0.7 or more

of total height have died, but 44 percent of those whose crown ratio are 0.3 or less have been lost. Young stands growing under a closed canopy of hardwood suffered virtually no mortality, whereas similar stands growing without crown shelter were more severely defoliated and in some as many as 65 percent of the trees have died. Pure or nearly pure stands of balsam fir were hit hardest, and mortality level was more closely associated with total basal area of fir than with average size of tree.

But perhaps the outstanding feature of the results is that the increased resistance to budworm attack entails no sacrifice or lowering of management standards. "Budworm-resistance-cuttings", made wherever practical, will doubtless be good business whether the budworm becomes epidemic in the spruce-fir region or not.

Time studies conducted on the budworm-resistance-cutting areas in the spruce-fir region point to several possible savings in pulpwood operations. The studies were made on four of the cutting areas, totalling 1,300 acres. They were undertaken to determine whether partial cutting costs more than traditional clear-cutting, an opinion widely held among operators. The results do not wholly support that opinion.

Raising the present minimum diameter limit for cutting pulpwood trees by about 3 inches would appreciably lower the man-hour requirements per cord. It takes twice as long to produce a cord of pulpwood from 5-inch trees as it does from 8-inch trees and three times as long as from 15-inch trees. The big reduction in required time occurs between the 5- and 10-inch classes; differences are less for the diameters between 10 and 15 inches.

Peeling and bucking are the most time-consuming operations in pulpwood production, requiring 24 and 22 percent respectively of the total time. These operations (along with limbing, which consumes 16 percent of the total time) would seem to present opportunities for mechanization.

Horses were used more efficiently by day-labor skidding crews than by piece workers who did their own cutting as well. The piece workers used their horses as little as 5 percent of the time, and in no case more than 42 percent of the time. On the average, the horses worked only 17 percent of the time. One skidding crew should obviously serve two or more cutting crews.

On one area where partial and clear-cutting were compared directly, partial cutting was more efficient than clear-cutting for all phases of the work and for trees of all diameters. The time saving averaged about 10 percent.

Power saws saved 12 to 31 percent in time, as compared with hand saws on one operation. The savings varied with species and tree size.

About twice as much area is cleared for roads on "stump-wood" jobs as on partial cutting jobs where the wood is skidded.

From these results it would seem that skillful management, good supervision, and some retraining of woods labor might well make partial cutting profitable and attractive from the production standpoint, as well as from that of forest management, silviculture, and resistance of the growing stock to budworm attack.

SUMMARY OF SPECIFIC JOBS IN 1949

Harvest Cuttings

1. Completed cutting on six 6-acre cutting-practice-level plots on the Pocono Experimental Forest.

2. Prepared working plans for series of cutting-practice-level plots averaging about 5 acres each on the Massabesic, Fernow, Hopkins, and Paul Smith Experimental Forests, and almost completed cutting of those on the Fernow.

3. Completed plans for compartment pilot-plant studies on the Massabesic, Pocono, and Fernow Experimental Forests, and began cutting on the Massabesic.

4. Prepared plans for and established small-woodland-forestry compartments on the Hopkins, Pocono, Massabesic, and Fernow Experimental Forests.

5. Added a shelterwood-cutting plot to a series of 3 methods-of-cutting plots established in 1939 on the Finch-Pruyn Experimental Forest.

6. Completed establishment work on all but one of the cutting areas in the spruce-fir type designed to determine the resistance of the residual stands to attack by the spruce budworm.

7. Found windfall losses negligible on some 950 acres cut to increase resistance of spruce-fir stands to budworm attack.

8. Found that mortality of balsam fir on one budworm-resistance cutting area after 6 years of heavy defoliation followed closely the pattern expected. Trees of small size, low vigor, and small crown are most susceptible, and trees in the open are more seriously damaged than similar ones under a hardwood overstory.

9. Found that mowing down of advance reproduction in the northern hardwoods type was ineffective in improving reproduction following harvest cutting.

10. Began surveys and 6.7 percent cruise of the new Penobscot Experimental Forest.

11. Found that 48 percent of fire-damaged white pines on the Massabesic Experimental Forest died during 2 years after the fire. Survival is considered high enough to warrant leaving damaged trees as seed source after a fire as insurance for a new crop.

12. Reexamined two sets of methods-of-cutting plots, 10 years old, in the Allegheny hardwoods type. Data are in process of analysis.

13. Reconnaissance of black cherry reproduction in Allegheny hardwoods points toward narrow strip cuttings as a promising method of regenerating this valuable species. Slopes facing from north to east seem easiest to regenerate to black cherry.

Stand Improvement

1. Initiated a formal study of the seasonal effectiveness of Ammate and sodium arsenite for tree killing. Found the King tree-tapper (developed for sugar maple tapping) an effective tool for preparing holes for poisons. Sodium arsenite was found to be quicker acting than Ammate.

2. Found that a two-man crew using the King tree tapper can effectively poison about 40 large unmerchantable Adirondack hardwoods per hour.

3. Poisoned defective beech to improve the growing stock on a partial cutting plot established in 1939 on the Finch-Pruyn Experimental Forest. In the 10-years since the first cutting, almost half the basal area growth was on trees of no prospective merchantability.

4. Determined that production of ties from material removed in improvement cuttings in Adirondack hardwoods is a marginal operation if only poor trees are used.

5. Completed draft of a publication on 10th year results of a thinning study in Virginia pine in Maryland.

6. Observations on Virginia pines pruned 6 years ago when 9 years old showed that about half the pruning wounds have healed completely; the best healing has occurred on the lower 4 feet of the bole; healing is less well advanced where large live limbs were pruned, and hard pitch formed where live branches were cut.

7. In the coastal oak-pine type, began exploratory studies of the effectiveness of silvicides in reducing sprouting of upland hardwoods.

Prescribed Burning

1. In the coastal oak-pine type, removed all oaks from 7 acres of a prescribed burning study begun in 1940 and reexamined pine reproduction on the plots.

2. Made the scheduled prescribed burns on 20 acres of an experiment begun in 1936 in the coastal oak-pine type.

Silvics

1. Reexamined conifers winter-injured in the Adirondacks in 1948. The injury, due to dry winds during extreme cold, affected southwest portions of crowns chiefly and has led to the death of 18 percent of affected trees.

2. Began exploratory study of the value of a proprietary deer repellent for protection of pine reproduction in an area of heavy deer population in the coastal oak-pine type.

3. Established four 1/40-acre deer exclosures with companion unfenced plots to determine the affect of deer browsing on pine reproduction in the coastal oak-pine type.

Costs And Returns

1. Devised and put into effect a uniform basic system of record-keeping for compartment pilot-plant studies at all experimental forests.

2. Partial analysis of time-study data show labor requirements per cord about 10 percent less for pulpwood from partial cuttings than from traditional clear-cutting in the spruce-fir type. Peeling and bucking were found to consume 46 percent of the time required to produce a cord of pulpwood.

3. Installed a 2-cord Connecticut-type charcoal kiln on the Massabesic Experimental Forest to provide opportunity for integrated utilization of materials removed in pilot-plant compartment cuttings.

Stand Studies In Mensuration

1. Completed field work on a study of growth rates of species by sites and vigor class within the cove hardwood type of West Virginia. Analysis work is in progress.

Tree Studies In Mensuration

1. A Virginia pine cubic-foot volume table was checked for use on the Beltsville Experimental Forest.

Planting

1. Completed the initial experimental planting in the scrub oak type of the Pocono Plateau designed to determine the species adapted to the rigorous site. A heavy crawler-type tractor with angle-dozer blade prepared wide, shallow furrows, at a cost of about $10.00 per acre.

2. Continued tests of silvicides and methods of application as an alternative for furrowing as site preparation in the Pocono Plateau scrub oak type.

3. Completed a reconnaissance of strip-mine bank revegetation problems in the Appalachian hardwoods type. Report in rough draft.

4. Completed installation of an experiment in reclamation of areas on the Hopkins Experimental Forest occupied by dense growth of Spirea species. Four species of planting stock and three methods of site preparation are being tested. First-year survivals were satisfactory, but costs of site preparation are considered high.

5. Installed a replicate of 1948 plantings of red and white pines on burned and logged sites on the Massabesic Experimental Forest. Both 1948 and 1949 plantings suffered heavy mortality from Pales weevil where plantings were close to areas logged since the 1947 fire, indicating it still is not safe to embark upon a reforestation program.

6. Examination of a 1939 planting of 192 Asiatic chestnut trees on the Allegheny Plateau revealed only 9 (or 4.6 percent) still alive. Six were from An Huei province of China, two from Miyzaki-ken in southern Japan, and one from Bell, Maryland.

Reinforcement Planting

1. Reexamined white pine underplanted in heavily thinned young oak stand of the Anthracite region and made a partial release cutting.

2. On the Beltsville Experimental Forest, found that first-year growth of loblolly pine, yellow-poplar and hybrid poplar trees planted in spots where slash piles were burned was greater than in scalped but unburned spots.

Direct Seeding

1. Several exploratory efforts at direct seeding of white pine on the Massabesic Experimental Forest were frustrated by whitefooted mice that consumed the seed.

2. Reexamination of airplane-seeded portions of the Massabesic Experimental forest disclosed that second-year germination had just about offset first-year losses of white pine seedlings. Heavily burned areas are still only 2½ to 15 percent stocked. Where the fire was moderate, and 4,000 and 8,000 seeds per acre were sown, respectively one-half and three-fourths of the milacres are stocked. Total number of seedlings per acre on the moderately burned area remained at about 1,300 and 2,300 per acre for the two densities of sowing.

PLANS FOR 1950

The following plans for silvicultural and related studies in forest management are presented by experimental forests and adjacent areas grouped by research centers. The plans include the participating work of the Upper Darby staff as well as that of personnel headquartered near research center offices or on experimental forests.

Adirondack Center, Including Paul Smith And Finch-Pruyn Experimental Forests

1. Cutting-practice-level plots--Paul Smith Experimental Forest.
   a. Mark plots.
   b. Arrange for cutting - spring and summer 1950.

2. Pilot-plant operations on softwood lands of Paul Smith Experimental Forest.
   a. Prepare working plan.
   b. Establish compartment boundaries.
   c. Inventory compartment to be cut during 1950-51.
   d. Mark and cut 1950 compartments.

3. Utilization and marketing of inferior hardwoods in Adirondack region.
   a. Continue search for markets adapted to problem species.
   b. Arrange to market hardwood pulp to be cut in spring and summer of 1950.

4. Killing of inferior hardwoods--Paul Smith Experimental Forest
   a. Continue scheduled treatments through spring 1950.
   b. Continue exploratory studies through summer season 1950.
   c. Prepare progress report.

5. Winter injury--Adirondack region.
   a. Gather additional field data.
   b. Prepare office report.
   c. Prepare article for publication.

6. Hardwood methods of cutting--Finch-Pruyn Experimental Forest.
   a. Prepare report for publication on results of Finch-Pruyn study.

7. Problem analysis of Adirondack problem area.
   a. Revise draft for submission.

Allegheny Plateau Center (Pennsylvania And New York)

Kane Experimental Forest

1. Prepare working plan for a study of strip cuttings to secure black cherry regeneration, in cooperation with the Allegheny National Forest.

2. Prepare working plan for a study of the release of 10-year-old black cherry reproduction on the 5- and 8-inch-diameter-limit pulpwood-cutting plots in Wolf Run, in cooperation with the Armstrong Forest Company. Harvesting of pulpwood on a 5-year and 10-year cutting cycle from the 11-inch-diameter-limit plots will also be begun in 1950.

3. Establish a shelterwood method of cutting in a portion of the crop-tree study area of the Wolf Run Experimental Forest, in cooperation with the Armstrong Forest Company.

4. Salvage all available information from past studies of forest planting by a re-examination of existing test plantations established by the Station in 1938-39. Prepare reports on results for guidance of any future program of reforestation in the Allegheny Plateau region.

5. Publish data on red pine source of seed plantation.

6. Provide such technical assistance as may be required in the development of the cooperative State-Federal wildlife management program for Allegheny National Forest.

7. Provide necessary guidance to Mr. Bertram Husch, graduate student at University of Michigan, in his study of the economic importance, silvics and ecology, silviculture and management, of black cherry, during progress of work on his thesis for a doctorate.

8. Analyze past studies to bring up-to-date, outline possible publication of results, and begin writing a bulletin on the management of Allegheny hardwood-hemlock forests.

Anthracite Center, Including The Pocono And Standing Stone Experimental Forests

1. Complete the initial cutting and summarize results on eight 6-acre cutting-practice-level plots on the Pocono Experimental Forest.

2. Start cuttings on the small-woodland-forestry areas on the Pocono Experimental Forest.

3. Start pilot-plant cuttings on compartments on Pocono Experimental Forest.

4. Continue measurements of precipitation and water yield from the watershed unit on the Pocono Experimental Forest.

5. Continue exploratory studies on the efficacy of silvicidal treatments for suppressing sprouts and suckers after cutting--on Pocono Experimental Forest and elsewhere.

6. Carry out follow-up cultural operations on the "high-order" and "good" cutting-practice-level plots recently established on the Pocono Experimental Forest, including the reduction of stump sprouts by poisoning and the killing of large unmerchantable trees by girdling or poisoning.

7. Prepare plans for cultural operations on compartments 27 and 34 of the Pocono Experimental Forest, including selection and pruning of softwood crop trees, poisoning or girdling of undesirable, unmerchantable trees, and planting of areas now covered with dense rhododendron.

8. Continue observations and maintenance of experimental plantings at various locations in the scrub oak type of the Anthracite Region.

9. In collaboration with the Station's Delaware Basin Research Center and the Pennsylvania Department of Forests and Waters, conduct a 50-acre field test of bulldozer furrowing and planting in the scrub oak type of the Delaware-Lehigh Experimental Forest, with special attention to the cost aspects of the operation.

10. In collaboration with the Delaware Basin group, obtain the necessary observations and evaluations of the silvicidal treatments applied to scrub oak vegetation in 1949.

11. Also, with the Delaware Basin group, carry out the scheduled planting of two 1-acre plots of scrub oak that were treated with ammate and Weedone Brush Killer 32 in 1949; follow up with appropriate observations on behavior of the brush and performance of the trees.

12. Continue observations and perform additional scheduled release work on white pine planted under heavily thinned young oak stands in selected study areas in the region.

13. Continue care and observations on the forest genetics plantations on the Standing Stone Experimental Forest. This work by Schreiner and assistants.

Coastal Oak-Pine Center

Beltsville Experimental Forest

1. Harvest the cutting-practice-level plots and carry out the plot treatments and other required work in connection therewith.

2. Prepare an over-all plan allocating areas for specific kinds of research use.

3. Complete working plan and establish small-woodland-forestry experiment.

4. Prepare a working plan for compartment pilot-plant studies, including the scheduling of cuts by compartments for the next few years.

5. Remeasure, analyze, and report on the results obtained from the study of planting in burned slash piles.

6. Design and initiate an experiment in thinning and pruning overstocked Virginia pine stands aged 10-15 years.

7. Harvest hybrid poplar cuttings from nursery, establish one or more new field tests, and install a test of cover crops for weed control in new hybrid poplar plantings.

Lebanon Experimental Forest And Adjacent Study Areas In New Jersey

1. Burn, as scheduled, 5 acres of plots in the 1936 study of prescribed burning; reburn and remeasure plots in old-field pine stand near Salem and possibly also those near Atsion (if inspection shows the desirability thereof).

2. Remeasure hybrid-pine planting plots in the Eastern Shore Experimental Forest, summarize data, and prepare a progress report.

3. Complete for publication the manuscripts being reviewed.

4. Revise the problem analysis after further discussions with representatives of the cooperating agencies.

5. Reexamine areas where silvicides were tried. Possibly start additional tests if an apparent need develops.

6. Make second treatment of deer repellent in January, and in late spring retally deer-repellent plots.

7. Remeasure plots of deer-exclosure study.

8. If possible, establish in cooperation with State Forester:
   (a) Prescribe-burning studies in two types of pine-scrub oak stands.
   (b) Prescribe-burning and thinning study in a pine stand 20 years old on an old-field site.

Eastern Shore Experimental Forest

1. Reactivate the experimental forest in cooperation with the Maryland Department of Forests and Parks.

2. Prepare working plan and establish a small-woodland-forestry experiment.

3. Prepare working plan and establish a set of four cutting-practice-level plots in immature loblolly pine.

4. Prepare working plan for a study of prescribed burning for hardwood control in immature stands of loblolly pine.

Mountain State Center, Including Fernow Experimental Forest

1. Prepare problem analysis for forest-management studies in the Mountain State problem area of West Virginia and adjacent area of Kentucky and Western Maryland.

2. Complete the growth study of cove hardwood species, including preparation of report for publication.

3. Complete the study of strip-mine revegetation, including preparation of report.

4. Make progress report on study of skid-road erosion.

5. Complete cutting on 2 farm-woodland areas and commence cutting on small product pilot-plant compartments.

Northern Hardwoods Center, Including Bartlett And Hopkins Experimental Forests

1. Recruise and establish sample trees on Church Pond budworm-resistance-cutting area. This will include the entire White Mountain - University of New Hampshire tract if the latter ownership is cut in 1950. Otherwise to include only 168 acres of National Forest land instead of total area of 256 acres.

2. Report on spruce-fir pulpwood time-study in collaboration with Penobscot center group.

3. Prepare report on results of hardwood-mowing study in cooperation with Green Mountain National Forest.

4. Compile and analyze data on development of hardwood reproduction following different overstory treatments.

5. Summarize and analyze data on experimental thinning areas.

6. Prepare an initial draft of northern hardwoods management manuscript.

7. Revise northern hardwood problem analysis.

Bartlett Experimental Forest

1. Prepare plan allocating areas for different kinds of research use of the forest.

2. Prepare working plan and install set of cutting-practice-level plots on the forest.

3. Prepare working plans for small-woodland-forestry and pilot-plant compartment studies on the forest.

Hopkins Experimental Forest

1. Hardhack conversion study:
   a. Continue scheduled cultural work and field observations and measurements.
   b. Prepare progress report on results obtained at the close of the second growing season.
   c. Prepare and put into operation a work plan for a study designed to explore the effectiveness of chemical weed and tree killers as site preparation in hardhack cover.
   d. Prepare work plan for a study to determine the factors that control natural restocking in hardhack and to provide some information as to how these factors may be guided or controlled.

2. Forest Genetics:
   a. Expand the 1949 plantings of hybrid poplars to include 50 additional clones for sapling clonal tests and 25 additional clones for the crop-tree clonal tests.
   b. Install a cover-crop experiment where various cover crops, tolerated by hybrid poplars, may be tested for their effectiveness in weed control.
   c. Conduct weed-control work on the 1950 hybrid poplar plantations at periodic intervals throughout the growing season.

d. At the end of the growing season, make annual measurements of height and observations on rust incidence on both the 1949 and 1950 hybrid poplar plantings.

3. Silviculture:
   a. Reinventory all study areas now established so that data obtained will be in accordance with the standard record-keeping system.
   b. Mark for light annual cuts from farm woodlot in compartment 10.
   c. As soon as a cooperator is located, make the initial cuttings on the four cutting-practice-level plots and on the two farm woodlots.
   d. Press negotiations with the International-Champion Paper Co., at Lawrence, Mass. to their final conclusion early in the first quarter of 1950.
   e. Develop local volume tables for each of the more important timber species on the Hopkins Forest.
   f. As time permits, reestablish and remeasure old cruise plots so that the data obtained may be used in evaluating growth rates in unmanaged stands on the Hopkins.
   g. Continue the work of establishing compartment boundaries, and making rather detailed location surveys of the features within their boundaries so that a system of compartment maps can be developed for the forest.

4. General:
   a. Keep weather data summarized currently so that the information may be readily available to interested agencies and institutions.
   b. Develop a simple, yet comprehensive educational program, which can be used in instructing youth groups such as the Williamstown Boys Club and the Williamstown Girl Scouts in the fundamental concepts of forest conservation.
   c. Develop a slide library of research activities on the Hopkins Forest, which can be used for I & E programs before local interested groups and service clubs, such as the Rotary, Lions, Faculty Club, Science Club, etc.
   d. Develop better fire-protection facilities for the buildings on the Hopkins.

Penobscot Center, Including The Penobscot And Gale River Experimental Forests

1. Complete study of wind damage following varying degrees of partial cutting.

2. Continue cooperative growth project with large timberland owners, aimed at developing satisfactory methodology for making growth and yield studies in all-aged spruce-fir-hardwood types.

3. Prepare working plan for and initiate tree-classification study for spruce and fir.

4. Conduct preliminary investigations into possible basis for site-quality index for second-growth all-aged spruce-fir-hardwood stands.

5. Prepare working plan and initiate study to determine character of normal stocking in second-growth all-aged spruce-fir-hardwood stands.

6. Continue analysis of budworm damage in relation to tree and stand characteristics.

Penobscot Experimental Forest

1. Complete survey of roads and boundary lines, and continue cruise.

2. Prepare research development and operating plan for the experimental forest.

3. Clear and establish headquarters site and begin construction of garage and storage building.

4. Build 3/4 mile of all-weather road into headquarters site.

5. In cooperation with Bureau of Entomology and Plant Quarantine, take aerial photographs of experimental forest.

6. Locate and construct water holes for fire-control purposes.

7. Prepare working plan for, and establish a set of cutting-practice-level plots.

8. Prepare sales agreement covering products from the C.P.L. plots.

9. Prepare working plan for experimental management of small-woodland-forestry areas.

Gale River Experimental Forest

1. Make such sample-plot remeasurements as required, under Westveld's directions.

2. Incorporate new findings in Westveld's manuscript (now under preparation) for spruce-fir silviculture.

White Pine Center, Including The Massabesic Experimental Forest

1. Complete initial harvest cuttings on the Massabesic Experimental Forest cutting-practice-level plots.

2. Cut eight of the pilot-plant compartments on the Massabesic Experimental Forest.

3. Make the first annual cut on the Massabesic Experimental Forest small-woodland-forestry study area.

4. Prepare a comprehensive program for white pine forest-management research based on the 1950 revision of the white pine problem analysis.

5. Complete the exploratory study of white pine cartridge planting in cooperation with Yale University.

6. Complete the over-all plan for utilization of the Massabesic Experimental Forest, including rehabilitation of 500 acres where post-fire salvage logging was necessary. Some 700 acres of merchantable timber are still available for further studies.

7. Continue field tests of hybrid poplars on the Massabesic Experimental Forest.

8. Explore the possibilities of a one-man charcoal plant, with emphasis on labor-saving devices and techniques. Relate this study to woodlot management needs.

FOREST ENTOMOLOGY

New Haven office of the Division of Forest Insect Investigations, Bureau of Entomology and Plant Quarantine

Detailed forest insect surveys by a Federal agency in the northeastern United States were made possible for the first time in 1949 as a result of the appropriation of funds for use by the Division of Forest Insect Investigations, Bureau of Entomology and Plant Quarantine.

A full-scale aerial survey was made of that part of the spruce-fir region in Maine known to be infested by the spruce budworm. At altitudes lower than 500 feet as little as 25 percent destruction of the 1949 foliage was visible to the unaided eye. The entire infested area was covered (using two planes) by state and Federal personnel, in less than 2 weeks. In addition, ground surveys were carried out during the feeding period by the state rangers. Egg-mass surveys were made during the latter part of July, with particular attention to areas noted by the aerial survey to be noticeably defoliated. These combined surveys indicated that heavy defoliation over large areas is unlikely in 1950.

A rather comprehensive survey of birch conditions in the northern hardwood forests was carried out in August in cooperation with the states of Maine, New Hampshire, Vermont, and New York and the Division of Forest Pathology and the Forest Service of the U. S. Department of Agriculture. The chief purpose of this survey was to determine the general condition of yellow and paper birch from the standpoint of both decadence and/or otherwise unexplained mortality--frequently referred to as "dieback".

Analysis of 121 plots--from eastern Maine to the Adirondack region of New York--indicates that the condition in Maine is much worse than in the remainder of the Northeast, while stands in New York are not as vigorous as those in New Hampshire and Vermont. It is obvious that more detailed conclusions could not be expected from the first season's observations. It is planned to examine one-third of the plots each year until the total number has been resurveyed; and some definite statements on improvement or decline can be expected annually beginning in 1950. A survey of scale-Nectria attacks on beech was made in conjunction with the birch survey. This survey

indicated a westerly extension of the beech scale in the White Mountains of New Hampshire, and also in additional towns in Maine. The insect was found in Vermont for the first time, and a new area of infestation was found in the Catskill Mountains in New York. The associated Nectria also was found in this latter area--the only known infection locality west of Bartlett, N. H.

Plantation surveys on an enlarged scale were carried out in cooperation with the Conservation Departments of Massachusetts and New York and the Entomology and Forestry Departments in Connecticut, New Hampshire, and Maine. Particular attention was paid to the degree of infestation and damage by the white-pine weevil, the European pine shoot moth, and sawflies. The plantation surveys will be continued and as data accumulate over a period of years they will furnish information bearing on the solution of the choice of site for plantations.

A report on the spruce budworm surveys has already been prepared and circulated. Reports on the birch survey and plantation surveys are in preparation and will be circulated in the near future.

SPRUCE BUDWORM INVESTIGATIONS

Major emphasis was given in 1949 to studies of various aspects of the spruce budworm problem.

The 74 observation points in New York were examined and a few larvae were collected at only three of the points. No larvae were found in New Hampshire or Vermont. In Maine a marked increase in population over 1948 was observed at 38 of the 62 observation points.

Studies of the survival of newly hatched larvae placed on trees in Maine in July 1948 showed that natural mortality factors reduced the population about 99.6 percent by the time the adults appeared in 1949.

Although there was a marked increase in spruce budworm populations in Maine, feeding was not sufficiently heavy in the sample plots and experimental cutting areas to cause appreciable defoliation or tree injury. Therefore, detailed defoliation records were not taken.

Parasite studies were continued at nine different localities in Aroostook County. Aggregate parasitization of the 1949 generation of budworms ranged from 50 to 78 percent at these points.

Eggs deposited in July 1949, which represented the potential population for 1950, were found to be more heavily parasitized than in July 1948. Parasitization ranged from 16 to 58 percent in 1949 as compared to a range of 9 to 32 percent the previous year.

A study of the role of birds in controlling the budworm was conducted in cooperation with the Fish and Wildlife Service. On one plot birds were eliminated by shooting. A comparison of the budworm population in this plot with a check plot where birds were unmolested indicated that birds destroyed from 5 to 7 percent of the budworm population. Actual numbers of budworms destroyed by birds were estimated to be between 22,000 and 29,000 per acre.

Studies of the effects of DDT on fish-food, fish, birds, and other wildlife in the forest were terminated in 1949. General conclusions from these studies are that a dosage of 1 pound of DDT in 1 gallon of oil solution per acre does not produce any serious effects on the fauna of forests and streams. It is true that this dosage will kill a high percentage of some species of aquatic insects; but streams become repopulated at a rapid rate. Some small fish may be killed, but in general this dosage is not considered to be serious to fish. Dosages of 2 pounds of DDT per acre have proved to be non-injurious to birds, whereas 5 pounds of DDT per acre results in nearly complete mortality.

PLANTATION INSECT STUDIES

The white pine weevil is the most important insect pest of forest plantations in the Northeast and studies have been continued in an attempt to control this insect by the application of insecticides. Extensive tests made in cooperation with the New York Department of Conservation during the past 4 years in applying DDT sprays from an airplane have not resulted in satisfactory control. Some small-scale tests with a helicopter conducted in Massachusetts in the spring of 1949 resulted in nearly 100 percent control of the weevil. More extensive tests will be conducted with a helicopter in New York during the field season of 1950.

FOREST PATHOLOGY

New Haven office of the Division of Forest Pathology,
Bureau of Plant Industry, Soils, and Agricultural Engineering

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DISEASE SUSCEPTIBILITY OF HYBRID POPLAR CLONES

The study of the resistance and susceptibility of hybrid poplar clones to Septoria canker was continued in 1949 by inoculations and field observations. Of 100 clones inoculated in 1947 and 1948 in the experimental plot at Cheshire, Conn., and in one of the Forest Service plantings at the Agricultural Research Center, Beltsville, Md., 19 clones gave evidence of high resistance and 15 clones proved to be highly susceptible. In June 1949, 78 additional clones, selected by Dr. E. J. Schreiner and planted as cuttings in a newly established plot at the Agricultural Research Center, were inoculated. Because of the small size of the young shoots only two trees of each clone were inoculated. The inoculated shoots were collected for examination in October and the results indicated that a high percentage of these clones may be resistant to the fungus.

Tests to determine the spread of the disease under natural conditions in plantings of hybrid poplar clones were established in four replicate plantings of 64 clones each, at the Agricultural Research Center. These clones had been selected from the 100 clones previously tested for susceptibility and represented both resistant and susceptible clones. One tree of each of 16 clones in a replicate was inoculated, the trees being selected in such a manner that loci of infection were regularly distributed throughout the planting.

The secondary fungi most frequently found on the cankers resulting from inoculations were isolated in pure culture. Four isolations of Fusarium species and two of Phomopsis species were used as the sources of inoculum to test the pathogenicity of these fungi. Trees of 5 clones in the greenhouse and 11 clones at the Cheshire plot were inoculated but in all cases the results were negative.

Data have been obtained from the plantings at Cheshire and Beltsville regarding the leaf-infecting fungi that cause premature defoliation and thus might affect the growth of the trees. Variations in susceptibility of the clones to these fungi have been recorded. In this connection,

a leaf-blotch which occasionally has caused heavy defoliation in young trees has been studied in detail. Known heretofore only in the conidial stage, the causal organism was studied in pure culture with the resulting development of the perfect stage, which has been found to be an undescribed species of Septotinia. Its pathogenicity was established by positive results from the inoculation of the leaves of hybrid poplar clones in the greenhouse. The mycological and cultural phases of the study are being published in Mycologia. Young trees of certain species of native poplars, grown at Beltsville, Md., have proved to be susceptible to the leaf blotch, particularly Populus Fremontii and P. trichocarpa.

Eighty-six hybrid poplar clones and several clones of species of poplar selected and grown by Dr. S. S. Pauley at the Arnold Arboretum, Harvard University, at Jamaica Plain, Mass., were tested by inoculations to determine their relative susceptibility to Septoria canker. Approximately four trees of each clone were inoculated in July 1949 and the inoculated shoots were collected in October for examination. About fifteen of these clones showed indication of resistance to the canker.

"DIEBACK" OF BIRCH

The fungi most commonly associated with birch mortality are Melanconis nigrospora, Melanconium betulinum, Gelatinosporium fulvum, Phomopsis species, Libertella species, three species of Fusarium, and two unidentified organisms. In June 1949 a total of 180 inoculations were made to test the pathogenicity of these various fungi on vigorous yellow and paper birch saplings in the nursery at New Haven. The results were all negative. In September a total of 544 inoculations were made with the same fungi on wild saplings of yellow and paper birch in northern New Hampshire. Preliminary results indicate parasitism by Phomopsis species and by one of the unidentified organisms.

Periodic examinations were continued of all birch trees inoculated with material from trees showing symptoms of virus infection. Only one symptom, a ring spot on the foliage, has been successfully transmitted. In no case has any indication of decline typical of dieback been observed on inoculated trees.

A nursery for the propagation and growing of all available species of birch hardy in southern New England has been established in Norfolk, Conn. In this nursery all fungi and viruses isolated from birch will be tested for pathogenicity.

A survey of birch condition in the northern hardwood region of northeastern United States, federally financed by an appropriation under the Forest Pest Control Act, was carried on jointly by the Bureau of Plant Industry, Soils and Agricultural Engineering and Entomology and Plant Quarantine and by state agencies in Maine, New Hampshire, Vermont, and New York. To sample yellow and paper birch stands across this region,

121 permanent plots were established, of which 63 were in Maine, 16 were in New Hampshire and Vermont, and 42 were in New York. On each plot approximately 35 trees were numbered and classified according to their overall condition. Analysis of the data shows that the birch situation is worst in Maine, intermediate in New York, and least serious in New Hampshire and Vermont. Reexamination of the trees on these plots in subsequent years will afford a comparison of the range and intensity of birch mortality.

RELATION OF DECAY IN PULPWOOD TO ITS FLOATABILITY

Industrial users of spruce and balsam fir pulpwood annually river-drive several hundred thousand cords and frequently hold it in dead-water storage until it can be utilized. Sinkage losses in these operations are considerable and variable according to the wood species involved; bolt position in the tree (butt, mid-bole, or top); number and size of knots; proportion of sapwood to heartwood; kind, stage and amount of rot; degree of seasoning at time of immersion; and the total length of time the wood is in the water. A better understanding of the relative importance of all these factors is essential if pulpwood losses in transit from forest to mill are to be held at a minimum.

In the summer and autumn of 1949 a total of 827 freshly cut bolts from living and recently-killed red spruce and balsam fir trees were selected, permanently tagged, weighed, and classified according to species, position in tree, size, ratio of sapwood to heartwood, specific gravity, number and size of knots, and kind, stage, and amount of rot. Of this number 102 bolts were immediately placed in the water and the remaining 725 were stacked for air seasoning over the winter and will be placed in the water in the early spring of 1950. All these bolts will remain in dead water storage until the fall of 1951 and will be examined periodically to determine their buoyancy.

PUBLICATIONS ON FOREST PATHOLOGY DURING 1949

Waterman, A. M., and Cash, E. K. Leaf blotch of poplar caused by a new species of Septotinia. Mycologia.

Hahn, G. G., and Miller, A. V. Rust immunity of Canadian black currants under field conditions in Connecticut. Plant Disease Reporter 33: 275-276.

---------- Further evidence that immune ribes do not indicate physiologic races of Cronartium ribicola in North America. Plant Disease Reporter 33: 291-292.

---------- Junipers previously reported blight resistant now proved susceptible to Phomopsis juniperovora. Plant Disease Reporter 33: 328-330.

SUMMARY OF JOBS DURING 1949

The susceptibility of 178 hybrid poplar clones to Septoria canker has been determined. Of these, 19 clones showed evidence of high resistance and 15 clones were highly susceptible to this disease.

A leaf blotch of young hybrid poplar clones was studied and the causal organism was foung to be an undescribed species of Septotinia. In plantings at Beltsville, Md., susceptibility of hybrid clones to this disease was variable but young trees of two native species of poplar, Populus Fremontii and P. trichocarpa, were highly susceptible.

Of the fungi isolated from dying birch, only two (Phomopsis species and an undetermined organism) show evidence of pathogenicity under artificial inoculation conditions.

A nursery has been established to study the relative susceptibility to "dieback" of all available species of birch.

A survey was made to determine the over-all condition of native stands of yellow and paper birch in the Northeast. The situation is worst in Maine and least serious in New Hampshire and Vermont; New York has an intermediate condition.

An investigation of the relative importance of the factors controlling sinkage losses in water-stored spruce and balsam fir pulpwood was started, with particular emphasis on the effect of decay upon such losses.

PLANS FOR 1950

Hybrid poplar clones that have shown evidence of high resistance to Septoria canker will be rechecked by inoculations. Observations will be made in the replicated plantings at Beltsville, Md., to determine under natural conditions the susceptibility of the clones and the rate of spread of this disease.

Study of the pathogenicity of the fungi and viruses associated with birch "dieback" will be continued.

A reexamination of at least part of the permanent birch survey plots will be made, and a comparison with previous conditions will indicate the over-all trend of the "dieback" situation.

Additional pulpwood bolts will be added to the floatability test to secure better representation of different kinds and amounts of rot.

WATERSHED MANAGEMENT

(forest influences)

NEW YORK CITY'S WATER PROBLEM

The most striking event during the past year with respect to water was the final arrival of a long-threatened water shortage in New York City and northern New Jersey. The spectacle of the largest metropolitan area in the United States being faced with a possible water famine was enough to make even the most thoughtless person stop and wonder "Why?"

Certainly the Northeast has awakened to the realization that an adequate water supply is a necessity for the continued prosperity of the region. For example, Eugene Grace has stated that any further expansion of the Bethlehem Steel Company's facilities in this area will definitely be contingent upon assurance of an adequate supply of water. This attitude may be considered typical of industry in general. Many communities outside the immediate shortage area are nervously examining their present water supplies and considering the possibilities for future increases.

The Northeast has a sufficient total quantity of water. The inadequacies arise from the distribution of water--in both time and space. Concentrations of population and industries have resulted in water requirements greatly exceeding supplies available from immediately adjacent areas. This condition has given rise to the need for importing water from greater and greater distances.

The expansion of New York City's water supply system is typical of this. In early days shallow wells were capable of furnishing sufficient water for the New York area. As the population increased, water requirements steadily grew until finally it was necessary to go to the Croton River, some 30 miles north of the New York City Hall, for increased supplies. An aqueduct from this area was completed in 1842; it had a capacity of 90 million gallons a day.

By 1883 supplies again were proving inadequate and it was necessary to construct a new aqueduct with a capacity of 285 m.g.d. The city and its water needs kept growing; they rapidly overtook supplies, and by the turn of the century it was obvious that new and much greater supplies were necessary. The next step in expanding the water supply was to go to the Catskill Mountains. An aqueduct was built to Esopus Creek, about 85 miles north of the New York City Hall, diverting the water of Esopus Creek and Schoharie Creek. This increased supply amounted to an average of 525 m.g.d.

By the time this Catskill system was completed in 1928, it was evident that even further expansion would be necessary. At this time plans were developed to divert water from the East Branch of the Delaware River, the Neversink River (a tributary to the Delaware River), and Rondout Creek (a tributary to the Hudson River). This project was delayed by litigation; so construction was not started until 1937. World War II caused more delay; so the project is still under construction. Completion is expected in 1955. This system is expected to add about 500 m.g.d. to the city's water supply. Thus the City of New York has been forced to reach out more than 100 miles to obtain adequate supplies of water.

As drain on the surface water supplies continues on an ever-increasing scale it has become evident that, although total yield may be adequate, the distribution of flow during the year is not commensurate with the most advantageous use. For example, the average annual water yield for the West Branch of the Delaware River (593 square miles) is 710 m.g.d., but the average annual minimum daily flow is only 48 m.g.d. The East Branch of the Delaware River, above the entrance of Beaver Kill, a watershed of 542 square miles, has an average annual yield of 760 m.g.d. while the average annual minimum daily flow is 60 m.g.d. As a natural result it has been necessary to construct large impounding reservoirs in which water from storm flows may be stored to provide adequate supplies during periods of low water.

WATERSHED CONDITIONS ARE IMPORTANT

An examination of various tributaries of the Delaware River indicates the great influence that land-use practices and watershed conditions may have on streamflow characteristics. The Lehigh and Lackawaxen Rivers, both tributary to the Delaware, have their headwaters in the Pocono Mountain area of northeastern Pennsylvania. The Lehigh watershed above Tannery, Pa., covers 322 square miles; the Lackawaxen above Hawley, Pa., covers 290 square miles. Both watersheds have about the same precipitation, an average of approximately 44 inches per year. Some 90 percent of the Lehigh above Tannery is forested, but only 38 percent of the Lackawaxen above Hawley is forested (the remaining 62 percent is largely pasture or cultivated land). The average annual water yield for the Lehigh is 435 m.g.d. and the average annual minimum daily flow is 52 m.g.d. The average yield of the Lackawaxen is 319 m.g.d. and the minimum daily is 28 m.g.d.

Of a total of 32 annual maximum daily flows, on a unit-area basis, the Lackawaxen was higher than the Lehigh in 21 instances. Of 15 of the annual maximum daily flows that occurred during the spring months of March, April, and May, the Lackawaxen was higher in 12 cases. The spring months are usually characterized by alternate periods of freezing and thawing, and a large part of the precipitation is in the form of rainfall.

An examination of the two areas was made during a rain storm that was preceded by a period of freezing and a slight thaw. All small streams in the Lehigh were running quite clear, but most of those in the Lackawaxen were very turbid. Muddy water was observed running off pastured areas in the Lackawaxen, but no surface runoff was observed on forested areas.

Soils in the pastured areas were frozen to a depth of 1-1½ inches with a dense, impervious type of frost. The top 1/4 inch had thawed, but the remaining layer of frozen soil was preventing infiltration of the rain water. Soils in nearby forested areas were soft and permeable, and no freezing was observed in the mineral soil.

This evidence indicates that during the spring months in the Lackawaxen drainage large quantities of surface runoff occur from frozen pasture areas and the water is thus unavailable to sustain streamflow during periods of low rainfall. In the Lehigh drainage a large part of the rain water is able to percolate through the soil and increase underground storage, from which it is given up gradually throughout the dry weather periods.

The states of New York, Pennsylvania, and New Jersey (under the guidance of INCODEL) have recently conducted a survey of the water resources of the Delaware Basin. During this survey, preliminary plans were prepared for the integrated development and use of available supplies. The first phases of such a water-development plan call for the construction of several large dams on the Delaware and some of its major tributaries. The success of this gigantic undertaking will hinge upon maintaining the maximum storage capacity in these reservoirs. Examination of watersheds above these proposed structures indicates that erosion from mistreated lands may seriously jeopardize the great investments by excessive siltation of the reservoirs.

All of the examples and figures cited here indicate the great influence that watershed conditions will have upon future water supplies for this entire metropolitan and industrial area. The importance and magnitude of the problems certainly justify a greatly expanded research program in the field of watershed management. Such a program will determine the basic relations between the land, its use, and water supply. This information is needed to insure the best use of watershed lands commensurate with conditions conducive to the maximum yield of water in the form of well-regulated flow.

SOIL FREEZING A SIGNIFICANT FACTOR

Studies of soil freezing (as influenced by various soil, climatic, topographic, and biotic factors) have yielded some significant qualitative relationships, allowed computations of certain tentative quantitative relationships, and pointed the way for additional studies. The significance of soil freezing is in the formation of concrete frost, which creates an impervious barrier to infiltration and thus results in rapid runoff of water.

Last year's annual report presented a summary of the qualitative relationships. During the past year additional analysis of data collected during the winter 1947-48 has resulted in the preparation of curves and tables that can be used for estimating the amount and depth of concrete frost formation; these are based on records of snowfall, temperature, and land use. The tables show the rate of formation and thaw of concrete frost under different temperatures, snow depth, and land use. These curves and tables are intended for use in the Allegheny Watershed.

Examination of these tables shows strikingly the influence of land use upon the occurrence and depth of concrete frost. Agricultural lands, either bare or row-cropped, show a high incidence of concrete frost formation, which extends rapidly to depths up to 12 inches when temperature deficiency accumulation reaches 400° with no snow mantle. Pasture and cover-cropped areas show slightly less distribution of concrete frost and shallower depths than bare areas. At 400° TDA with no snow, pastures would be expected to have frost to 8 inches depth and cover-cropped lands to 6 inches depth. Mistreated forest areas and severely grazed or burned woodlands show widespread occurrence of concrete frost, but depth is less than on agricultural lands. At 400° TDA with no snow these grazed or burned woodlands would have up to 5 inches of frost.

Wooded areas that have been neither grazed nor burned and thus have a comparatively undisturbed forest floor show so little concrete frost that it could not be considered more than a trace under the temperature conditions that existed during the period of record collection.

It is recognized that these tables and curves are more or less first approximations and much additional information must be accumulated to insure the validity of the figures, but statistical tests have shown the high significance of the various factors, so it is thought that the relative effects of the different land-use conditions will prove reliable.

This marks the first attempt to evaluate quantitatively the influence of land use upon concrete frost formation. The implications of this line of endeavor are rather striking. First, the use of such information in the hydrologic analysis of past major floods will allow a much better evaluation of the effect of recommended land use changes in reducing flood conditions. Second, information of this type will be highly valuable in flood forecasting, since it will serve in evaluating a very important factor in the development of flood potentials. Third, plans for watershed management to increase water supplies by inducing increased infiltration, thereby reducing high-water flows and increasing low-water flows, will benefit from such information.

SUMMARY OF JOBS DURING 1949

Water Relations

Streamflow

To determine the influence of changes in vegetation upon streamflow precipitation relations in the Delaware River basin, the Station during 1949--

1. Continued the collection, tabulation, and compilation of streamflow and precipitation data for the Dilldown watershed of the Delaware-Lehigh Experimental Forest.

2. Completed installations for measuring precipitation and streamflow on a watershed in the Pocono Experimental Forest.

3. Completed a geologic study of the Dilldown watershed.

4. Completed a soils survey of the Dilldown watershed.

5. Completed a detailed work plan for watershed studies on the Dilldown watershed.

6. Completed the first draft of a work plan for watershed studies on the Pocono Experimental Forest.

7. Established a second climatic station in the Dilldown watershed.

8. Started collection of data for use in a problem analysis of the Delaware basin.

Quality

To determine the effect of forest management, changes in vegetation, logging and other access roads, and skid roads upon quality of water, the Station--

1. Started a study to determine soil loss from logging roads under different cutting-practice levels on the Fernow Experimental Forest.

2. Completed a working plan for the development and research use of the Fernow Experimental Forest, including provisions for watershed management and forest management studies.

3. Started periodic measurements of water turbidity and color at Dilldown and the Pocono Forest.

4. Made bacteriological analyses of water samples from the Dilldown watershed and the Pocono Forest.

Soil Relations

Ground Water

To determine the effect of changes in vegetation upon amount and movement of ground water and the relation of ground water to streamflow, the Station--

1. Collected, tabulated, and compiled records of ground-water elevation on the Dilldown watershed.

2. Developed curves of ground-water fluctuations on the Dilldown watershed and correlated these with streamflow.

3. Made exploratory excavations preparatory to digging another shallow well on the Dilldown watershed.

Storage

In a study of the relationship of cover and soil to the amount of water stored in the soil--

1. Completed calibration of 28 electrical soil-moisture units and installed them at four different sites in the Dilldown watershed. These are installed in vertical batteries of seven units each through the soil profile.

2. Started periodic observations of soil moisture at each of the permanent sites in the Dilldown watershed.

3. Completed a soils survey of the Dilldown watershed. Computed areas of different soils encountered, determined amount of rock and volume weights for each soil horizon.

4. Computed series of factors, based upon volume weights and rock content, to determine volume of water held in each soil horizon for each observed soil moisture percent on the Dilldown watershed.

Infiltration

In a study of the relationship of cover, soil, and other factors to the incident, type and depth of frost--

1. Completed analysis of frost data collected in the winter of 1947-48 and prepared curves and tables of soil freezing and thawing for use in the Allegheny watershed.

2. Presented progress reports of soil-freezing study at Eastern Snow Conference and annual meeting of the American Geophysical Union.

PLANS FOR 1950

During the year 1950 activities in watershed management research will be directed mainly along three lines of endeavor. First will be the development of problem analyses for two large areas that have great importance as watersheds.

The West Virginia area watersheds contribute about one-half of the flow of the Ohio River through the Monongahela, Little Kanawha, the Kanawha, Guyandot, and Big Sandy Rivers. A large part of the headwaters of the Potomac River lies in this area. It has been stated that a drought in West Virginia affects about 25 million people who depend to a greater or lesser extent upon the water that originates here.

The Delaware River and its tributaries furnishes water in whole or in part to some 15-20 million people and to a number of the major industries of the country. In addition, it is the only readily available source for badly needed increases in water supplies for many of the cities and smaller communities in southern New York, New Jersey, and eastern Pennsylvania. Many of the problems arising from dense populations, and the industry, mining, agriculture, and other activities to which water supplies are vitally important.

The second line of activity will be the continuation of specific watershed studies that are now under way. This will include completion of installations, collection and processing of data, and preparation of progress reports.

The third line of endeavor will be an expanded attack upon the problems associated with soil freezing. This will be carried on by the installation of controlled experiments to determine quantitative relations between important soil, climatic, and biotic factors and the type and depth of soil freezing. These studies will be at some of the more northerly branch stations where freezing conditions are more consistently severe. In addition, plans are being made to study certain soil and moisture factors in laboratories where temperatures and moisture conditions may be controlled.

Anthracite Center

Complete installations and continue collection of records on the Pocono Experimental Forest Watershed.

Delaware Basin Center

Continue collection and processing of data from the Delaware-Lehigh Experimental Forest.

Complete topographic survey around watershed boundary and determine true area of Dilldown watershed.

Start vegetation survey of Dilldown watershed.

Continue participation in scrub oak conversion studies on the Delaware-Lehigh Experimental Forest as described in the section on Forest Management (p. 17).

Install shallow wells near swamp in Dilldown to measure fluctuations of perched water table.

Determine siltation in Schoharie Reservoir in the State of New York and make a survey to determine sources of sediment and land use conditions contributing to this problem.

Complete problem analysis for the Delaware River basin.

Mountain State Center

Continue measurements of erosion from logging roads on Fernow Experimental Forest and prepare progress report.

Make a problem analysis for the Mountain State problem area, including such river basin areas as Monongahela, Potomac, Kanawha, etc.

Initiate watershed management studies on the Fernow Experimental Forest if personnel and funds permit.

Other Centers Of Work

Field observations on frost formation will be made in accordance with an over-all plan to be developed by the Station staff.

THE FLOOD CONTROL SURVEYS

Runoff was less than normal in most streams of the Northeast in 1949. During the first quarter of the year it was slightly above normal as a result of heavy precipitation in later December and early January; but in the last three quarters it was substantially below normal. New York and New England experienced a summer drought. Here streamflow in the latter part of the year was only about 50 percent of normal. Groundwater levels, high early in the year because of intensely heavy recharge, sank by the end of the year to record or near-record lows.

UNUSUAL STORM AND LANDSLIDES STUDIED

Two serious floods occurred in the Northeast during the year. The first, early in January, caused local damages on the eastern tributaries of the Hudson River in New York and on the Upper Housatonic and Nangatuck Rivers in Connecticut.

The second, in June, occurred on the headwaters of the Potomac River in Virginia and West Virginia. Twelve lives were lost and property damages of more than $5,000,000 were suffered as a result of extraordinarily heavy precipitation on forested mountain watersheds. A peak discharge of more than 1,000 cubic feet per second per square mile occurred on a 60-square-mile drainage area in Virginia. Peak discharges in the South Branch of the Potomac River in West Virginia exceeded all previous records. Large amounts of debris from numerous landslides in the areas of heavy precipitation complicated water movement and accounted for much of the damage in the flood plains. Large areas of the best agricultural bottom land were covered with several feet of debris which permanently removed them from cultivation.

A study was made of this storm, particularly with respect to landslides, in an attempt to determine their cause. The lands on which many of these slides occurred were within the Monongahela and and George Washington National Forests and had been under intensive protection for 20 to 30 years. However, all of the lands affected had been logged, burned, and grazed for an unknown number of years prior to being purchased and included in the National Forest. There was evidence that these lands had not recovered to a point where they could resist the severe stresses developed by this unusual storm.

Most of the landslides started on steep slopes near the tops of hogbacks or divides. In these areas natural regeneration had been slow; it consisted of inferior young stands of a rather open and brushy type. In general, slides did not occur where thrifty normal stands had developed. In fact, when some slides reached better stands below, the slide was restricted in width, and a few slides stopped altogether.

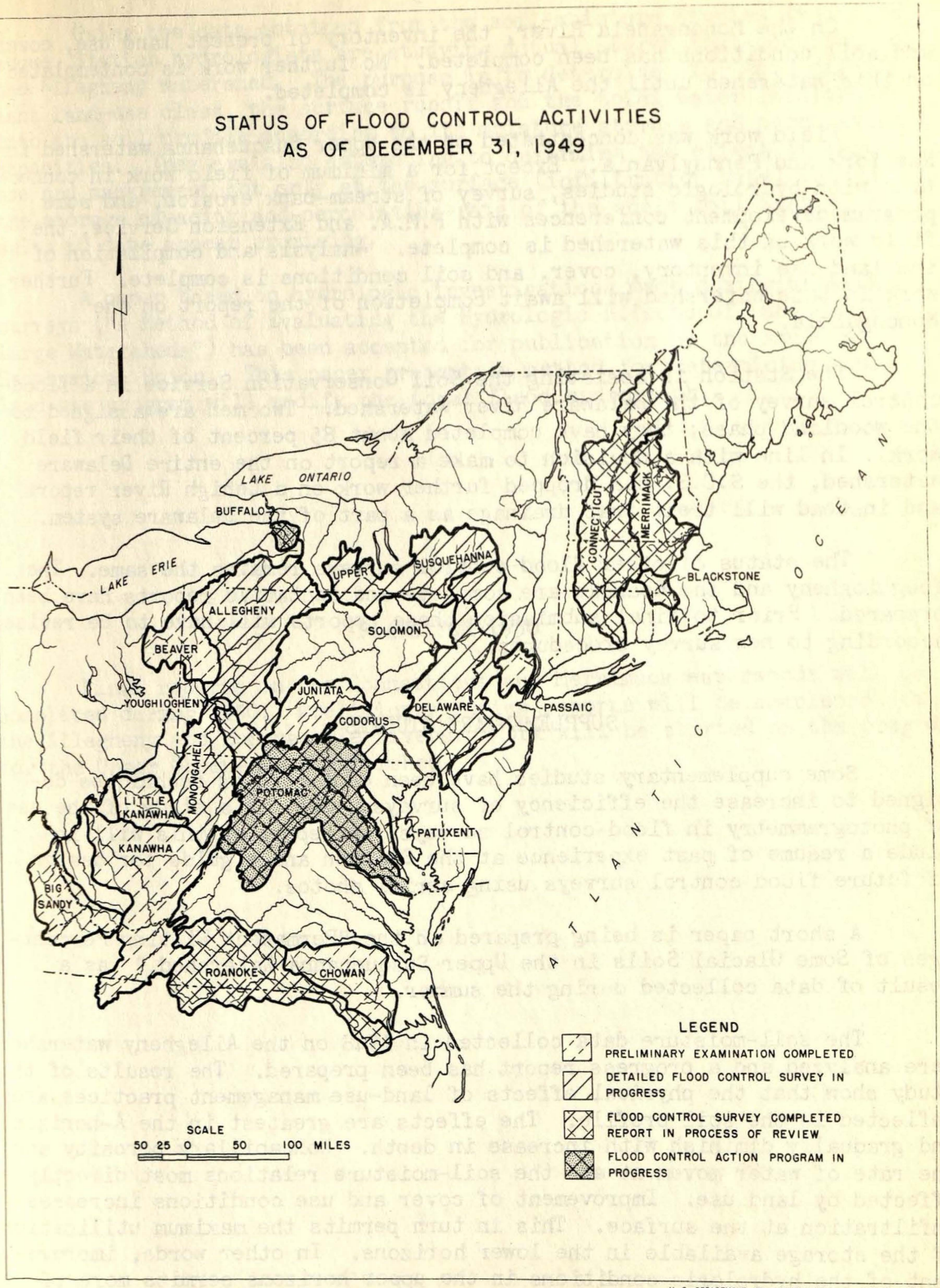
This storm showed how long it takes land to recover fully from past abuse. It showed the urgency for early initiation of good land-use and management practices. Results of the study also emphasize the need for extreme care in applying even good cutting and logging practices on steep mountain slopes, particularly slopes steeper than 65 percent. Poor cutting practices should be ruled out entirely.

STATUS OF FLOOD-CONTROL SURVEYS

The report on the flood-control survey of the Connecticut River was revised after preliminary review by the Washington office of the Forest Service, and a tentative report was published by the Station. This was submitted to state agencies in New Hampshire, Vermont, Connecticut, and Massachusetts and to interested cooperators for review and comment. It was also transmitted to the local offices of Federal agencies in accordance with Federal Inter-Agency River Basin Committee procedures. Meetings were held in Connecticut, Massachusetts, and New Hampshire to discuss the report. Connecticut and New Hampshire agencies have generally concurred with the recommendations in the report. A few questions are still pending in Massachusetts. No meeting with state officials has been held as yet in Vermont. A conference was held with the U. S. Engineers and the U. S. Geological Survey to iron out several points. Further work in collaboration with other U. S. Department of Agriculture agencies (Production Marketing Administration, Bureau of Agricultural Economics, and Agricultural Extension Service) has delayed submission of a final report to the Department of Agriculture in Washington.

All work on the Merrimack River survey report has been completed and a preliminary draft has been prepared. Revision of the cost section will be necessary in accordance with new survey procedures. This report will be revised soon.

Office computations of field data previously gathered in the Allegheny River basin were carried on throughout the year. The land-use inventory and damage-appraisal phases have been completed. With the assistance of highway departments and their engineers, a special study was made of sedimentation damage to highways in this watershed, and other data were collected for purposes of evaluating highway damage in this and adjacent watersheds. This study showed that extraordinarily high damages are caused by storms. Such damage, however, can be reduced to a very low figure by proper land-use and management programs on a watershed basis, according to increasing evidence where such programs are under way.



U. S. DEPARTMENT OF AGRICULTURE . FOREST SERVICE
NORTHEASTERN FOREST EXPERIMENT STATION

On the Monongahela River, the inventory of present land use, cover, and soil conditions has been completed. No further work is contemplated on this watershed until the Allegheny is completed.

Field work was concentrated on the Upper Susquehanna watershed in New York and Pennsylvania. Except for a minimum of field work in connection with hydrologic studies, survey of stream-bank erosion, and some program-development conferences with P.M.A. and Extension Service, the field work on this watershed is complete. Analysis and compilation of the land-use inventory, cover, and soil conditions is complete. Further work in this watershed will await completion of the report on the Monongahela.

The Station is assisting the Soil Conservation Service in a flood-control survey of the Delaware River watershed. Two men are assigned to the woodland phase; they have completed about 85 percent of their field work. In line with a decision to make a report on the entire Delaware watershed, the S.C.S. has dropped further work on a Lehigh River report and instead will treat that drainage as a part of the Delaware system.

The status of other flood-control surveys remains the same. The Youghiogheny and the Roanoke are complete and tentative reports have been prepared. Prior to final submission these reports will have to be revised according to new survey procedures.

SUPPLEMENTARY STUDIES

Some supplementary studies have been continued on techniques designed to increase the efficiency of surveys. One is a study of the use of photogrammetry in flood-control surveys. A report on this will include a resume of past experience at the Station and a guide for design of future flood-control surveys using aerial photos.

A short paper is being prepared on the "Permanent Wilting Percentages of Some Glacial Soils in the Upper Susquehanna Watershed," as a result of data collected during the summer.

The soil-moisture data collected in 1948 on the Allegheny watershed were analyzed and a progress report has been prepared. The results of the study show that the physical effects of land-use management practices are reflected in the soil profile. The effects are greatest in the A-horizon and gradually diminish with increase in depth. Noncapillary porosity and the rate of water movement are the soil-moisture relations most directly affected by land use. Improvement of cover and use conditions increases infiltration at the surface. This in turn permits the maximum utilization of the storage available in the lower horizons. In other words, improvement of the hydrologic conditions in the upper horizons permits more effective use of the storage capacity in the underlying horizons even though there has been no material improvement in their structure.

Using the data obtained from the soil-moisture studies described above, Station hydrologists are studying actual storms that occurred on the Allegheny watershed. The purpose is to determine, for each significant land-use class, the surface runoff and the total water infiltrated into the soil profile according to its moisture storage and percolation capacities. They are also attempting to determine the effect of land use and management not only at the surface (infiltration rate) but on the storage capacity and percolation rate of the whole soil mantle. Results to date appear promising.

A paper based on hydrologic investigations made during watershed surveys ("A Method of Evaluating the Hydrologic Effects of Land Use on Large Watersheds") has been accepted for publication by the American Geophysical Union. This paper presents a method for determining how a land-use program will modify the total flood hydrograph.

PLANS FOR 1950

Final reports on the Connecticut and Merrimack watersheds will be completed during 1950. Preliminary review reports will be completed for the Allegheny and Monongahela Rivers. Work will be started on the program for the Upper Susquehanna watershed.

THE FOREST SURVEY

STATUS OF THE SURVEY

The Forest Survey in the Northeast continued at a rapid pace during 1949. Figure 2 indicates the area covered by the field inventory up to December 31, 1949, and represents about 29,450,000 acres of forest land. This area includes all of the forest land of New Hampshire, Vermont, and West Virginia, 33 percent of Maryland, 16 percent of Pennsylvania, 49 percent of New York, and 5 percent of Maine.

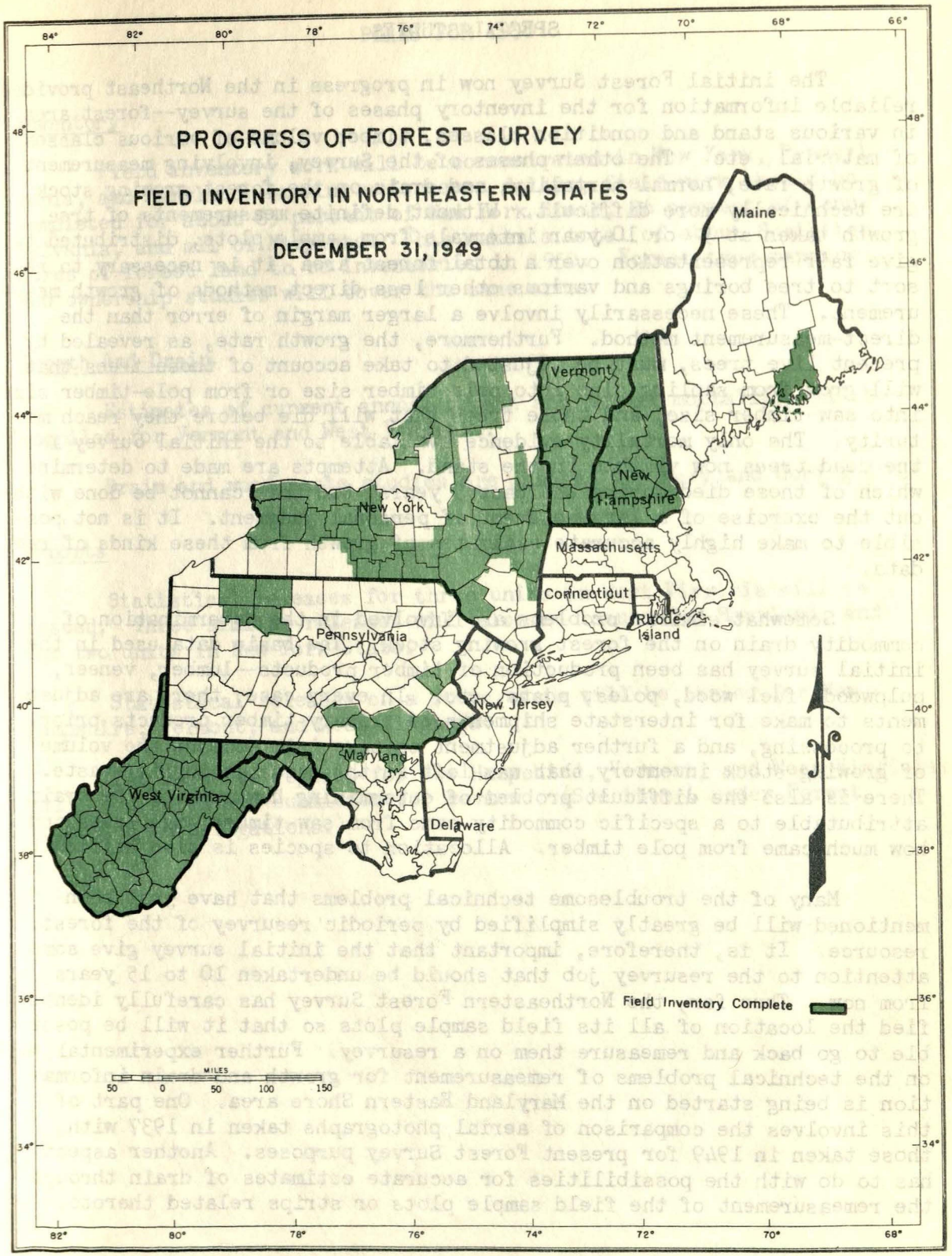
Forest-type mapping was allowed to lag slightly behind the field inventory in order to accomplish as much inventory work as possible before winter conditions made field work difficult. Field maps at a scale of 1 inch equals 1 mile have been completed for all of New Hampshire, Vermont, and West Virginia and for portions of New York, Pennsylvania, and Maryland.

Surveys of the consumption of fuel wood, fence posts and miscellaneous farm wood products were completed in the field for West Virginia and Vermont along with a study of wood waste in New York. These data when compiled will be used in estimating the drain of timber from the forests. Growth and drain estimates were compiled for New Hampshire.

In addition to field inventory and drain work, data on forest land ownership in Maryland, Pennsylvania, and New York were collected.

Compilation of forest inventory data was given additional impetus during the year. All inventory data gathered by the field crews were punched on tabulating cards preparatory to compilation. Seven statistical releases covering units in Maine, New Hampshire, and West Virginia were issued in 1949. Three additional unit statistical releases for West Virginia, and a state statistical report for New Hampshire were prepared and are being reviewed prior to publication. The writing of the final interpretive report for New Hampshire has been started.

Through the cooperative efforts of the states, complete aerial photographic coverage was assured for New York, Pennsylvania, and Maryland.


PROGRESS OF FOREST SURVEY
FIELD INVENTORY IN NORTHEASTERN STATES
DECEMBER 31, 1949
Maine
Vermont
New Hampshire
New York
Massachusetts
Connecticut
Rhode Island
Pennsylvania
New Jersey
Maryland
West Virginia
Delaware
N
Field Inventory Complete
MILES
50 0 50 100 150
84° 82° 80° 78° 76° 74° 72° 70° 68° 66°
48° 46° 44° 42° 40° 38° 36° 34°

SPECIAL STUDIES

The initial Forest Survey now in progress in the Northeast provides reliable information for the inventory phases of the survey--forest area in various stand and condition classes, timber volume of various classes of material, etc. The other phases of the Survey, involving measurement of growth rate, normal mortality, and drain on the forest growing stock, are technically more difficult. Without definite measurements of tree growth taken at 5- or 10-year intervals from sample plots, distributed to give fair representation over a total forest area, it is necessary to resort to tree borings and various other less direct methods of growth measurement. These necessarily involve a larger margin of error than the direct-measurement method. Furthermore, the growth rate, as revealed by present live trees, must be adjusted to take account of those trees that will grow from sapling size into pole-timber size or from pole-timber size into saw-timber size, and those trees that will die before they reach maturity. The only mortality evidence available to the initial Survey is the dead trees now visible in the stand. Attempts are made to determine which of these died during the past 5 years, but this cannot be done without the exercise of a large element of personal judgment. It is not possible to make highly accurate estimates of growth from these kinds of raw data.

Somewhat similar problems are involved in the determination of commodity drain on the forest growing stock. The basic data used in the initial survey has been production of timber products--lumber, veneer, pulpwood, fuel wood, poles, posts, etc. In every case, there are adjustments to make for interstate shipments of primary timber products prior to processing, and a further adjustment to take into account the volume of growing stock inventory that was left in the woods as logging waste. There is also the difficult problem of determining how much of the drain attributable to a specific commodity came from saw-timber size trees and how much came from pole timber. Allocation to species is also difficult.

Many of the troublesome technical problems that have just been mentioned will be greatly simplified by periodic resurvey of the forest resource. It is, therefore, important that the initial survey give some attention to the resurvey job that should be undertaken 10 to 15 years from now. Thus far, the Northeastern Forest Survey has carefully identified the location of all its field sample plots so that it will be possible to go back and remeasure them on a resurvey. Further experimental work on the technical problems of remeasurement for growth and drain information is being started on the Maryland Eastern Shore area. One part of this involves the comparison of aerial photographs taken in 1937 with those taken in 1949 for present Forest Survey purposes. Another aspect has to do with the possibilities for accurate estimates of drain through the remeasurement of the field sample plots or strips related thereto.

PLANS FOR 1950

Inventory

Field inventory work will be concentrated in New York, Pennsylvania, and Maryland. Barring unforeseen delays, field work should be completed for about 85 percent of New York State, 26 percent of Pennsylvania, and all of Maryland. This makes a total of about 8 million acres of forest land to be inventoried in 1950. Forest-type mapping and ownership studies will cover the same area.

Growth And Drain

Estimates of current annual growth and normal mortality will be compiled for Vermont and West Virginia.

Drain and wood-waste studies are planned for Maryland during 1950.

Reports

Statistical releases for three units in West Virginia will be issued. Three similar releases will also be issued for Maryland, and for two units in New York State.

Statistical releases on a state basis will be issued for New Hampshire, Vermont, and West Virginia.

Interpretive reports for New Hampshire, Vermont, and West Virginia, will be drafted and submitted for review. (See item 4 under Forest Economics Investigations.)

THE FOREST RESOURCE

and related economic studies

The research in forest economics during 1949 involved five main projects. Some of the highlights from each one of these are offered in the following sections.

PRICES AND MARKETS OF FARM WOODLAND PRODUCTS

Preliminary studies of the farm woodland products marketing situation in the three northern New England States and on the Del-Mar-Va Peninsula area of eastern Maryland and Delaware were brought to completion and published as Station papers. The highlights of these two studies were summarized in last year's annual report.

Experience gained in the preliminary studies opened the way for the initiation of a cooperative project with the Extension Forester of Rhode Island. This consists of a state-wide survey of the markets and prices of farm woodland products. The field survey has been completed and the results are now being summarized for publication. This publication will contain (1) a directory of all the buyers of farm woodland products in the State, with an indication of the product or products that are bought by each, (2) quality and species specifications that are commonly used in the purchase of each class of product, (3) general price information as of the latter months of 1949. As with all surveys of this kind in which the Station participates, it is hoped that the initial experience gained by the cooperating agency will prove valuable enough to justify a new survey at periodic intervals to bring the information up to date.

Most farm products that are bought and sold in the channels of business are now priced according to some kind of grading system, because long experience has proved that prices based solely on quantity are a "pig-in-a-poke" proposition. Neither the buyer nor the seller can be quite sure that he is getting fair value in such an exchange. Furthermore, prices that are not tied to some definite specifications of quality usually vary over a wide range between the lowest and the highest. It is, therefore, very difficult to know just what price competitors are giving or getting for the comparable quality of product.

Recognition of these economic facts has led to the establishment and use of standard grading systems for grain, dairy, and poultry products, vegetables, and most of the other important products that farmers put on the market. But not so with woodland products. Only a small fraction of the sawlogs, pulpwood, and other forest products coming off farm woodlands every year are sold according to grade. This being the case there is not a clear incentive to produce the best quality of woodland products and not much chance for getting the full value of the high-quality material that is produced.

The attack on this problem began a number of years ago when the Forest Products Laboratory and other agencies undertook the development of a system of log grades for standard hardwood factory lumber. That effort culminated in 1949 with the publication of the resulting log-grading specifications. Other log-grade specifications for material suitable for cutting into railroad ties and construction timbers; and for logs that are suitable only for local-use products such as the lowest grades of rough crating lumber, industrial blocking and such products, have been developed by a special committee of Forest Service personnel.

With these basic log-grade specifications now at hand, the staff assigned to the farm woodland products marketing project began a series of test-demonstrations to determine what, if any, modifications of the standard log-grade specifications are necessary to make them usable in various localities of the Northeast. This investigation was also designed to determine whether the average log scaler at a sawmill can be taught the log-grading technique in 3 or 4 days of instruction.

The first test-demonstration was held at a mill in western Pennsylvania. The results there indicated no difficulty in applying the standard log-grade specifications--even to black cherry logs, a species that was not included in the Laboratory's experimental runs. A similar test is in progress in West Virginia and others are scheduled for the early months of 1950. The results of this work are being made available in a series of short releases for local use. These will later be consolidated in a Station paper.

The development by the Connecticut-Agricultural Experiment Station of a cinder-block kiln for production of charcoal has aroused considerable interest in other areas that have an oversupply of low-grade hardwoods from farm woods. Several woodland owners in West Virginia were near the point of erecting one or more of these kilns in the hope of selling the charcoal to the large chemical plants in the Kanawha Valley. Local forestry interests were concerned about the available markets for charcoal. A brief survey of the actual charcoal markets was made. It showed that charcoal had priced itself almost entirely out of the chemical industry market. Several plants that formerly used large quantities of charcoal are now using substitutes. Domestic use of charcoal is too small to justify the building of kilns. Although the report of this survey was negative, it points out the necessity of determining market

outlets before initiating a project. In this case the survey prevented investing of private funds in a project that most likely would have failed.

OWNERSHIP OF SMALL FOREST HOLDINGS IN 23 NEW ENGLAND TOWNS

Considerably more than two-thirds of all the commercial forest land in the Northeast is in private holdings smaller than 5,000 acres. The personal interests and economic position of these small owners have a vital bearing upon the general problem of how to foster better management of the forest resource. It is a well known fact that the majority of small woodland owners, in the Northeast as elsewhere, have so far shown little concern about the timber-producing condition of their land. If such concern does exist, it has not been very effective in raising the standards of cutting practice to levels that will assure good timber productivity of the land.

What are some of the reasons for this seeming indifference? An adequate answer to this question would require some rather extensive studies that have not yet been undertaken. It is, however, possible to throw some light on the situation by the case-study method. That is what was attempted in 1948-49 through a small project in which the Station cooperated with Harvard University and the Federal Reserve Bank of Boston. The study covered the private forest land in holdings of 10 acres or more in 23 towns[2] distributed throughout the New England States. These towns were selected to give representation of that area in New England located between the extensive forests (predominently in large holdings) and the lands that are primarily agricultural or urban. The 23 towns contain about 450,000 acres of land, of which 278,000 or 62 percent are in forest holdings of 10 acres and more. This forest land is presently held by 2,106 private owners. The average size of holding is 132 acres.

The commonly-heard reference to "the forest-land owner" as though he were some well-defined class of person with a specific set of economic interests is an oversimplification. The analysis of the occupational status of the owners of small forest holdings in these 23 towns shows that these people represent a wide variety of occupations. The owners of wood-using plants hold less than 24 percent of the forest acreage. They are followed by business and professional people who hold a little less than 19 percent. Full-time farmers hold about 12 percent. The rest of the forest land (45 percent) is owned by persons in various other occupations as shown in figure 3.

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[2]The subcounty division of local government, corresponding to what, in some other states, is called the township.

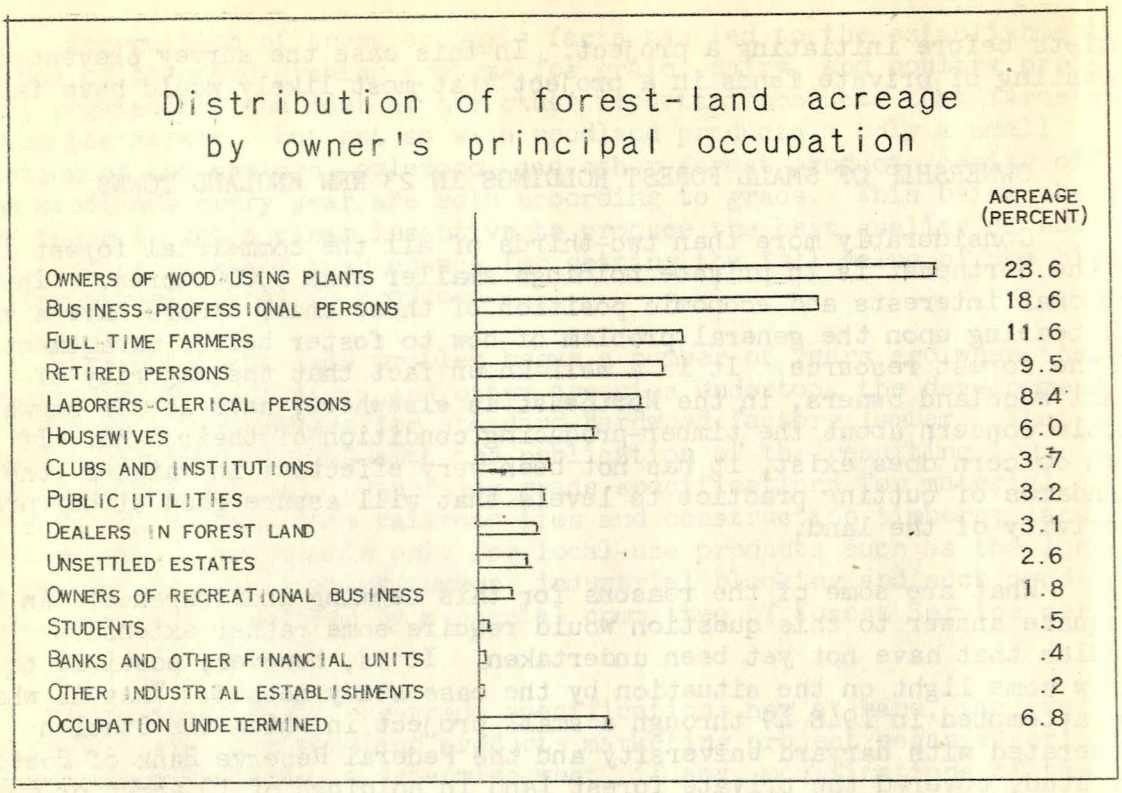

Figure 3. Less than one-quarter of the acreage is held by the owners of wood-processing plants.

The fact that the owners of more than three-quarters of the forest acreage in these 23 towns have major occupational interests that do not directly involve the use of their land for timber production goes a long way to explain the lack of concern about forest management. The majority of these people look elsewhere for their principal source of livelihood. The owning of forest land is somewhat incidental to their main occupation.

The majority of these small woodland owners are, of course, aware that their land has timber values. About 62 percent of the acreage is held by persons who list timber values as one of their principal reasons for holding forest land (table 2). But a considerable number of these owners also list some other major reason. It is rather significant that 38 percent of the acreage is held by persons who do not include the timber values at all in their major reasons for holding the land.

These facts present both a challenge and an opportunity. The challenge calls for extending the scope of forestry extension services so that they will more adequately reach those persons whose occupations lie outside the wood-using industries and full-time farming. Woodland owner cooperatives and agencies like the New England Forestry Foundation, Conwood Incorporated, and private consulting foresters could probably

TABLE 2.--DISTRIBUTION OF FOREST LAND ACREAGE ACCORDING TO OWNER'S REASONS FOR HOLDING IT, BY OCCUPATIONAL GROUPINGS

Occupational grouping	Total holding	Acreage held by owners for --						
		Timber values	Recreational purposes	Satisfaction of owning land	Residential use	Sale later at higher price	Use as pasture	Other uses
	Acres	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Owners of wood-using plants	65,734	100	1	2	..	..	..	..
Business-professional persons	51,736	49	41	14	21	10	3	5
Full-time farmers	32,561	66	2	20	3	15	16	7
Retired persons	26,648	46	30	32	19	8	1	3
Laborer-clerical persons	23,418	51	11	21	18	14	9	10
Housewives	16,859	33	17	21	21	22	2	13
Others	61,085	50	34	2	2	16	1	27
All owners	278,041	62	23	12	9	10	6	10

assume a much more prominent role in providing technical service for many of these small woodland owners who find their own time and effort too fully engaged to permit them to give much attention to woodland management.

The opportunity stems from the fact that a considerable part of the land is held by persons who are apparently under no heavy financial pressure to liquidate the timber values. Many of these properties are not being operated because the owners object to the kind of timber cutting that they would normally expect from a commercial sale of their timber. The opportunity lies in showing that good cutting practices can be made to harmonize with the nontimber values that the owners wish to preserve.

There is also opportunity in the fact that 60 percent of the land is held by persons who recognize timber values as being important. Here is a basic interest to build upon. The job is to convince these people that timber is a crop and that the culture of trees requires about as much care and intelligence as the culture of any other soil crop. Timber crops in quantity and of good quality are definitely not a mere windfall that nature automatically bestows upon those who do nothing but wait.

EXPERIENCE OF THE OTSEGO FOREST PRODUCTS COOPERATIVE ASSOCIATION

The evaluation of the experience of the Otsego Forest Products Cooperative Association of Cooperstown, New York, was completed in 1949. The major findings of this study are summarized as follows:

No attempt to organize a forest cooperative should be launched until the sponsors have obtained a reliable estimate of the volume of timber that is likely to be available to the proposed cooperative in competition with other enterprises also drawing raw material from its area of operations. Such an estimate should include information on location, volume, quality, rates of growth and drain, accessibility, ownership, and current utilization of the timber. The over-all estimate should be realistically discounted to take account of all important factors that will have an unfavorable effect upon timber procurement: volume on tracts or in properties too small for economic operation, volume in stands that have been reserved from cutting, volume of unmerchantable species and quality, volume held by persons who will not be willing to join the cooperative or to do business with it, and volume not available for various other reasons. The sponsors should have reasonable assurance that the woodland owners are open-minded in their attitude toward cooperatives and that the necessary membership can be enlisted.

The sponsors should, prior to formal organization, thoroughly familiarize themselves with the basic principles and practices of cooperatives in general and with forest cooperatives in particular. If the laws of the state do not specifically require that these basic principles be written into the charter and bylaws as a condition for legal incorporation, the organizers should do this on their own initiative. The well-tested principles of cooperative organization provide for workable administration under democratic control of the membership.

Many forest cooperatives have failed because they made no attempt to resolve the conflicting interests of woodland owners and processors of timber products. A cooperative that provides management services and operates its own processing plant has some very important advantages over one that limits its activities to management and marketing. Whether a proposed forest cooperative should establish a processing plant or confine itself to more limited services cannot, however, be decided on the basis of general principle. Much depends on the existence or nonexistence of well-established local processing plants capable of turning out quality products and maintaining favorable market outlets. If such plants are available and the owners are willing to collaborate with the cooperative in its forestry program, they should be given a fair trial. Small portable mills that cut poor-quality lumber on an intermittent basis are usually not satisfactory outlets for a cooperative that wants to promote forestry.

Insofar as feasible, the financial resources of the cooperative should be obtained from its members. Membership fees or required ownership of stock should be more than a mere token. No arbitrary minimum can be specified, it should, however, represent a real investment on the part of each member. Loans from outside sources should not be the kind that impose conditions that will interfere with the main objectives of the cooperative. There is an advantage in starting with moderate capital outlay, but in no case should the enterprise be so small that it cannot justify the employment of a competent full-time manager. A considerable sum

should be available for the necessary early promotional activities and losses of the initial shakesown period.

The bylaws of the cooperative should clearly separate policy-forming responsibilities from the managerial function. The former powers should reside in the membership and in its board of directors. The management responsibility should be conferred upon a person hired specifically for that job. He is the key person in the whole organization. Ideally he should be a good business man with a thorough knowledge of the products handled by the cooperative. He should have a knowledge of forest management and a sincere desire to promote it on all the woodlands of the community, nonmember as well as member. He should understand cooperative principles and be convinced that they can be put into practice.

Forest cooperatives justify their existence, in the long run, by their accomplishments in fostering the practice of good forestry. This implies cutting practices that are in line with the best that is known about silviculture tailored to meet owner objectives, feasible utilization, and market outlets. The program should be kept up to date with advancing knowledge and modified through constant checking of the key factors such as growth rate, distribution of tree sizes and species, reproduction, etc. It is recommended that cooperatives periodically invite outside review of their forest practices, not only as a stimulus to maintain high standards, but with the possibility that suggestions for improvement will be obtained.

An effective and sustained educational program is a "must" for forest cooperatives. Such a program will, of course, be designed to inform the members on how to improve the growing stock in their woodlands, and how to harvest periodic crops with the maximum long-range return to themselves. Contacts by fieldmen, field demonstrations, simple and newsy publications, exhibits of various kinds, and special community affairs such as a forest festival are some of the effective methods that can be used.

RESTOCKING OF FIRE-DAMAGED FOREST LANDS IN SOUTHWESTERN MAINE

Disasterous fires swept over some 130,000 acres of forest land in southwestern Maine during the autumn of 1947. Practically all of the timber stand, estimated at 211 million board feet of sawlog material and 400,000 cords of pole-size material, was killed or damaged by the fire.

Recognizing the need for action programs to aid in timber salvage operations and in rehabilitation of the burned-over forest land, the State of Maine requested the assistance of the Station in a series of surveys and studies that would provide data useful in deciding what should be done.

Studies carried out prior to 1948 included a survey of the burned area to find out how much salvagable timber there was on it. This was followed

by some experimental planting and seeding on burned areas of the Massabesic Experimental Forest to determine the hazard of Pales weevil damage to planting stock while salvage cutting was in progress and to test the practicability of seeding from aircraft. A third group of studies dealt with the land-rehabilitation problem. The studies made in 1948 were designed to give reasonably precise measurements of the restocking conditions in the second growing season after the fire and to determine how much of the forest land acreage will require some form of artificial regeneration in order to re-establish a new stand of timber of desirable species within a reasonable time.

The procedure involved a careful examination of some 340 sample plots located to provide a fair representation of the entire burned-over area. This sampling technique was applied with an intensity calculated to give estimates that fall within a range of error of not more than plus or minus 5 percent.

Of the 130,000 acres of forest land burned over, some 44,400 acres (34 percent) appear to be adequately stocked with desirable species (fig. 4).

An additional 28,900 acres not yet adequately stocked appear to have sufficient sources of seed. The total acreage that shows reasonable promise for natural regeneration or that has an adequate stand of pole and saw timber left after the fire and salvage operations adds up to 73,300 acres, or 56 percent of the area that was burned over.

The remaining 56,700 acres are lands that have been left without any adequate seed source. This area (44 percent of the total acreage burned over) cannot be expected to regenerate naturally--at least not with desirable species, and not within any reasonable period of time. Further study of this large area that has no adequate seed source indicates that some 34,000 acres are lands on which planting would be practical, and should be given high priority.

Competition by hardwood weed species (gray birch, scrub-oak, and others) was found to be lighter than expected but still, a serious problem to overcome in getting desirable species re-established. About 40 percent of 34,000 acres recommended for planting has 5,000 or more weed hardwood seedlings per acre.

Although no breakdown was made of the areas having fewer than 5,000 seedlings per acre, it is estimated that half of this area would have 2,000 to 5,000 weed seedlings per acre and the other half would have relatively light hardwood competition. It is reasonable to believe that competition from weed hardwoods will increase during the next few years; areas now relatively free of such growth doubtless will be invaded.

It seems obvious that the planting job, if it is to be accomplished at all, should be initiated without undue delay. It may soon be impossible to plant without expensive preplanting site preparation in the form of clearing.

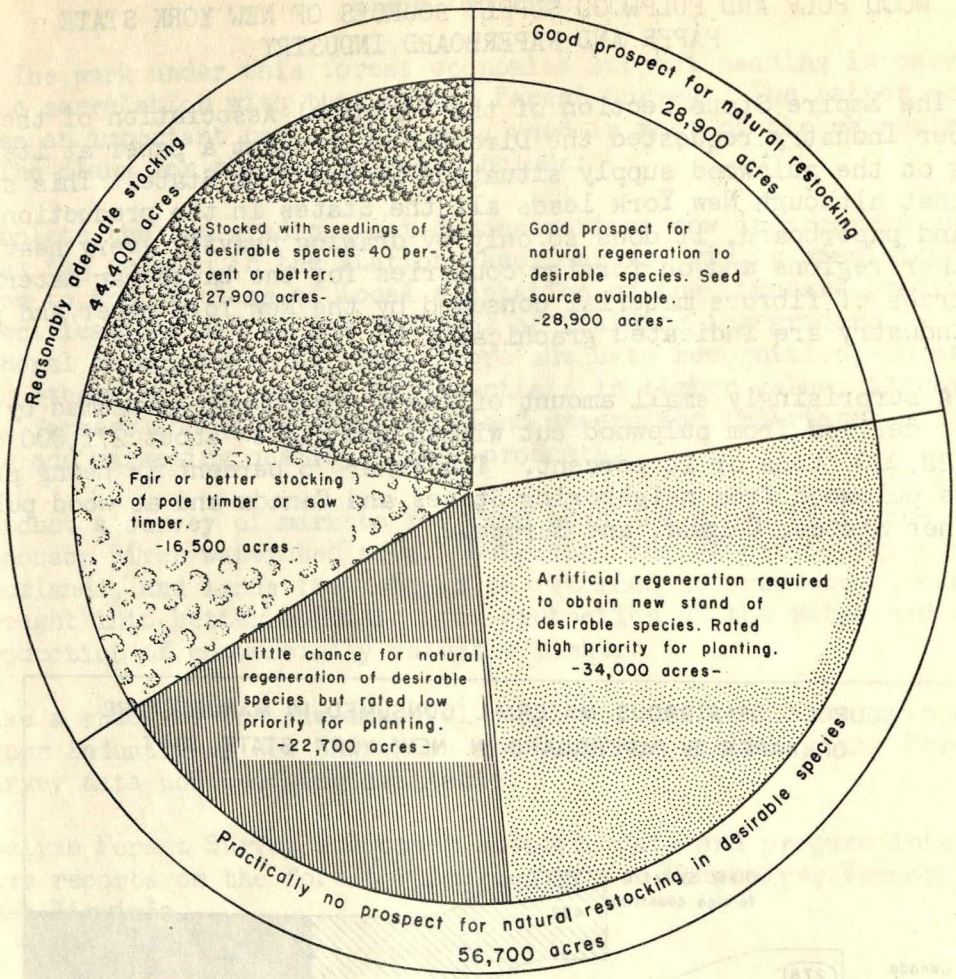
Good prospect for natural restocking
28,900 acres
Reasonably adequate stocking
44,400 acres
Stocked with seedlings of desirable species 40 percent or better.
27,900 acres-
Good prospect for natural regeneration to desirable species. Seed source available.
-28,900 acres-
Fair or better stocking of pole timber or saw timber.
-16,500 acres-
Artificial regeneration required to obtain new stand of desirable species. Rated high priority for planting.
-34,000 acres-
Little chance for natural regeneration of desirable species but rated low priority for planting.
-22,700 acres-
Practically no prospect for natural restocking in desirable species
56,700 acres

Figure 4.--Some 56,700 acres of the land burned over by the forest fires of 1947 do not have an adequate source of seed.

Making allowances for the scattering of seedlings of desirable species that are and will be present on those areas recommended for planting, it is estimated that an average of 700 trees per acre should be planted to give desirable stocking for production of good quality timber.

On this basis it would be necessary to have about 27 million trees to do the full job on 39,000 acres. A nursery production of about 5 million trees per year would be adequate to get the job done in about 6 years.

WOOD PULP AND PULPWOOD SUPPLY SOURCES OF NEW YORK STATE PAPER AND PAPERBOARD INDUSTRY

The Empire State Section of the Technical Association of the Pulp and Paper Industry requested the Director to present a paper at its May meeting on the pulpwood supply situation in New York State. This study shows that although New York leads all the States in the production of paper and paperboard, it does so only by drawing heavily--very heavily--upon other regions and on foreign countries for the basic raw material. The sources of fibrous material consumed by the New York paper and paperboard industry are indicated graphically in figure 5.

A surprisingly small amount of the new wood pulp consumed by the mills is derived from pulpwood cut within the State--about 271,000 of the 1,128,000 tons or 24 percent. The other 76 percent is being procured as pulpwood from neighboring States and Canada and as wood pulp from other States, Canada, and Europe.

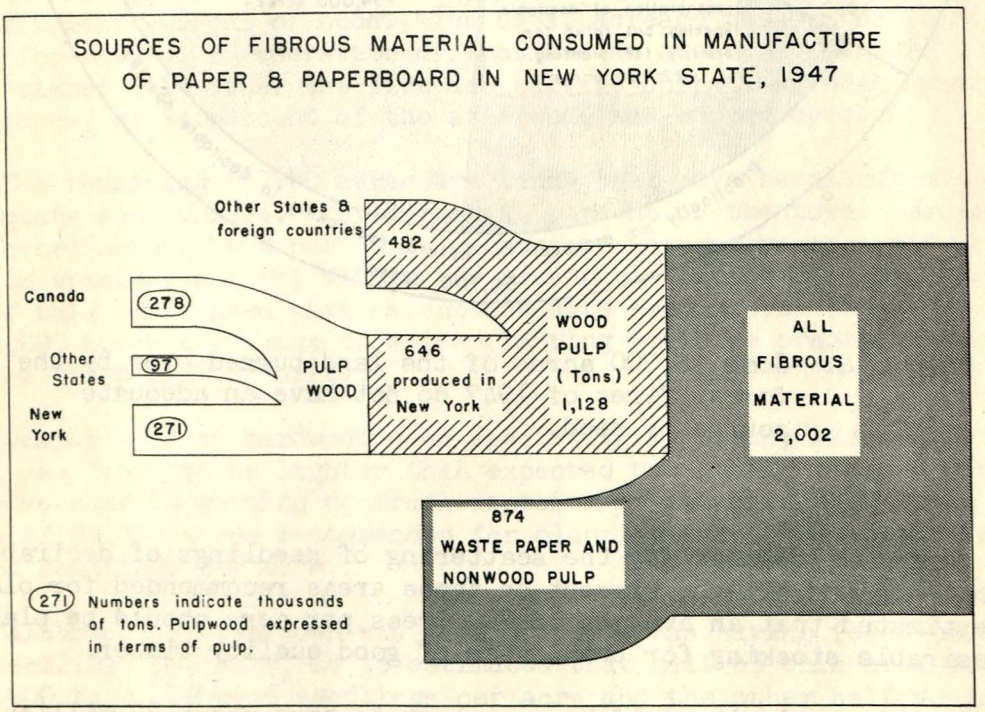

Figure 5.--Only a small part of the fibrous material comes from New York's forests.

PLANS FOR 1950

The work under this forest economics subject heading is carried on in close correlation with that of the Forest Survey. The latter activity provides an important part of the data used in most of the economic studies. The plans for the coming year include:

1. Complete the log-grading test-demonstrations now in progress and publish the results in the Station Paper series, giving special attention to the problems of local adaptation of the standard grading specifications and to the problems of training log-graders. The general objective is to obtain more adequate recognition, in price and otherwise, of quality differentials in timber value; therby showing farmers and other small woodland owners the importance of growing and marketing quality timber products.

2. Conduct a survey of markets for farm woodland products in the Monocacy River watershed area. Determine the extent to which the woodlands, and lands that should be returned to tree cover, can be brought into better condition for protection of the watershed and production of commercially valuable timber.

3. Make a study of the raw-material supply situation of the pulp and paper industry of New Hampshire and Vermont, utilizing the Forest Survey data now becoming available.

4. Analyze Forest Survey and other economic data and prepare interpretive reports on the forest resources of New Hampshire, Vermont, and West Virginia.

FOREST UTILIZATION

THE PROBLEM OF LOW-QUALITY MATERIAL

The full potentialities of forest management can be reached only if and when there is an active and adequate market for all of the species, classes, and grades of wood that comprise the forest yield. Although the outlets for forest products in the Northeast are many and varied, their ability to absorb the "skim milk" portion of the forest yield is not proportionate to the amount available annually.

The Station has long been aware of this situation, and since the installation of its Forest Utilization Service in 1944, has been directing much effort toward improving the situation. Utilization of increasing amounts of low-grade forest products can be stimulated in many ways. Efficient extraction and conversion of the better elements of our forest stands will tend to raise the profit margins and permit the inclusion of additional low-grade items as economic raw material. The development of new products that can use the low-grade materials themselves effectively, is another approach. Still another is to investigate the practicability of processes which can use parts of forest yield now wasted.

In the over-all utilization picture there is one species "standout": this is beech. Beech, as a species, is not being adequately utilized. Consequently the Station arranged for the organization of a Northeastern Technical Committee on the Utilization of Beech. On this are representatives of the Station, universities, state forestry departments, and the Forest Products Laboratory. The committee developed a list of 24 subjects covering all phases of the use of beech and individual members accepted assignments to compile papers to be published by the Station. At this time, new research was not contemplated; however, some was started at several of the cooperative institutions. The Station, in cooperation with local agencies, obtained test material. Although the project is to carry through 1951, substantial progress on a number of the papers was evident at year-end.

In its effort to promote an adequate utilization system, the Station has given considerable attention to dissemination of available information. To this end 11 papers in the logging and milling field alone were prepared for publication. One was presented at the National Meeting of the Forest Products Research Society. One complete paper and a part of a compendium was presented at the United Nations conference on the Conservation and Utilization of Natural Resources.

Another appeared as a section in text book on logging. One was a Farmer's Bulletin, entitled "Logging Farm Forest Crops in the Northeast." Thirty thousand copies were printed and distributed within two months. As another major activity the Station has, through plant visits and correspondence, advised hundreds of interested people in utilization and related problems. It stimulated, guided, and participated in research and followed up leads to promising new products or processes.

LOG-GRADING TESTS

One important field was log-grading. Use of standard primary-product grades offers the forest manager and plant operator a systematic approach to aspects of quality problems. Although there are no generally acceptable standard specifications for all the kinds of wood that can be cut from the bole of a tree, there is information available that will go a long way toward meeting many of the problems.

The nucleus of this is found in the proposals for the grading of hardwood logs suitable for production in factory lumber, published by the Forest Products Laboratory in 1949. During the year the Station developed a plan for demonstration testing of these grades and other grading information.

Tests in Pennsylvania and West Virginia showed that the system as presently developed reasonably achieved its objective; namely, the screening out of sub-grade material; segregation of screened material into use classes; and, within the use class, division into grades representing high, medium, and low-value products. To further the use of these grades, introductory seminars were held with farm foresters in both the southern and northern portions of the region.

LOGGING METHODS AND EQUIPMENT

In the logging field, the Station followed with considerable interest the operation of a Swiss cableway system. This system, developed as an economical method of logging steep country, particularly where watershed values are important and where selective cutting is desirable, were installed in eastern Canada and the Adirondacks. Operations were satisfactory. Although costs of skidding from hitherto inoperable upper slopes were not low, they are not higher per unit than those for tractor and sulky on more gentle slopes. For general use in other parts of the United States, it appears that heavier equipment will be required.

A significant development in power chain saws has been the router-type chain. The Station made several trials of this type against old types on standard makes of saws and found that the new type cuts almost twice as fast as the old. It also stays sharper longer. Sharpening, when required, is quicker and easier. Another important trend in the

power-saw field is the manufacturing of very light one-man saws, the need for which was early recognized by the Station. A number of our suggestions, including better grips, spiked bars, and attached chain oilers have been accepted and are included on some current models.

The Station also tested "throw-away" bow-saw blades, which were developed by a Norwegian manufacturer to make use of the efficient bow saw more convenient. Although these are more accurately fitted and sharper than presently available Swedish and American blades, it is questionable if they can hold their sharpness much longer. However, the price is attractive, one-third less.

To bring new developments in logging to the attention of operators, the Station cooperated with the Woodsmen's Club of Old Forge, N. Y., in arranging for a Woodsmen's Field Day. A crowd of over 3,000 people had an opportunity to inspect the harvesting equipment of 20 manufacturers. The Station organized and held a 2-week logging school for its experimental forest personnel. The course included methods of practical logging operation, maintenance of equipment and small tools, log-grading, and handling of wire rope. Safety was featured in all operations.

A TRULY PORTABLE SAWMILL

In the milling field, the Station aided the Forestry Department of the University of West Virginia in developing plans for a truly portable sawmill. This outfit is carried on a trailer and drawn by truck tractor on which is mounted a power unit. It is short-coupled so it can make the sharp turns typical of mountain roads. The mill is sturdy and designed so that the ends of the ways, which are detachable, can be positively alined.

It is now being operated by the West Virginia Forest Products Association for the local Soil Conservation District. It moves from farm to farm cutting material cheaply for the home use of farmers who do their own logging. The availability of tools such as this will go a long way toward making proper management of woodlands profitable and popular.

The Station also observed with interest two types of automatic slab saws installed at sawmills to cut slab wood into short lengths. They eliminate the labor of one man, an important saving especially in small mills. Efficient devices such as these are significant in holding down waste-handling costs.

WOOD WASTE

In the over-all utilization picture, full utilization is important. The large quantity of wood "wasted" in primary processing has

long been a matter of considerable and widespread concern. Many efforts have been made by the industries and the research agencies serving them, to find profitable uses for this material. However, such questions as the location, type, and volume of waste available have usually been answered only in a general way.

The Station aided the Northeastern Wood Utilization Council in organizing a field survey to obtain specific information on possible "waste centers." The survey was carried out under a grant from the Federal Reserve Bank, and covered the six New England States. It showed there were 39 points around which at least 20 tons per day of manufacturing waste were produced within a 15-mile radius. Detailed information on this subject is available from the Federal Reserve Bank of Boston. The Council already has used the data as the basis for a wall-board "clinic," held under the auspices of Harvard University, involving people specifically engaged or interested in the production of this commodity.

To get waste into use, the Station cooperated with a New York State steel company in locating supplies of sawdust for use in a new smelting process that uses low-cost anthracite coal in which 2 to 3 percent of sawdust is mixed. The Station also followed with interest a New York State lumber manufacturer's sawdust briquetting machine, which dries green sawdust and produces extruded round briquettes about 2 inches long, suitable for stoker use. It consulted with a pulp company interested in finding uses (other than fuel) for bark. Using mostly oak, which has a fibrous bark, the company's investigations have shown that the fibrous portion is suitable for use in insulating materials or as a component of wet-formed wall-boards and that the dust fraction can be readily sold to a linoleum manufacturer.

WOOD AS FUEL

The use of wood as a domestic fuel has been declining in rural as well as urban areas due to the convenience of other fuels. The need for an efficient wood-burning furnace to offset this has long been recognized. A Rhode Island firm now is manufacturing such equipment based on the designs of D. E. Howes, former director of the Vermont Bureau of Industrial Research. This warm-air furnace will operate on two fillings a day at capacity; with the drafts closed it will hold the heat with one filling up to 5 days. The Station made arrangements to test this furnace at a Connecticut garage and a New Hampshire Logging Camp, and in several typical rambling farm homes. The tests showed satisfactory performance, and the company is now carrying forward a sales promotion campaign. It is also working on modifications to permit the burning of chipped wood and use with water-heating systems.

USES FOR CHIPPED WOOD

Through the use of inexpensive portable chippers, low-grade wood of all types can be converted into a uniform, easily handled form. A cooperative study was developed in Connecticut to determine the cost of chipping up trees removed in release cuttings, thinnings, and land clearing. The cooperators are the Northeastern Wood Utilization Council, the State of Connecticut, the Station, and a manufacturer who supplied a chipping machine.

Data was obtained on man-hour requirements and yield of chips per cubic foot of wood. The product was distributed to the Agricultural Experiment Station for composting, to the University for drying experiments prior to use as cattle bedding and poultry litter, to the Fish and Game Department Farm for use in developing better food and cover conditions, and to the State Highway Department for testing mulch value in holding new banks. Additional quantities were supplied to paper manufacturers, wall-board manufacturers and makers of heating equipment.

The Station also participated in four wood-chipping demonstrations designed to show Connecticut and Rhode Island farmers the usefulness of this process. It followed with interest experiments at the Rhode Island State College designed to determine the rate of de-composition and acidifying effects of hardwood and softwood chips when added to the soil and usefulness of wood mulches in fruit culture.

WOOD AS FIBER

Further to investigate use of low-grade wood, a study was made of the roofing or linoleum-felt industry in the northeast. This industry uses more than 200,000 cords annually of pitch pine, Virginia pine, southern pine, and a variety of hardwood; in addition perhaps, an equal tonnage of waste paper and wood flour. Up to 10 years ago, this latter was the only form of wood used, the remaining component being rags. Modern defibrators produce from round wood a fiber that is almost as satisfactory as rag and which is more stable in price. As a result, there is growing pressure within the industry to increase wood use to a point consistent with technical requirements of the products.

The Station study indicated there are several problems that hold back the use of wood. One is the lack of flexibility of wood fiber comparable to that of rag. A second is inadequate separation of fiber bundles in the converting process. Further, there is lack of standardized testing proceedures within the industry. The solution of these problems might also help in increasing the use of low-grade wood.

CHARCOAL MARKETING PROBLEMS

Manufacture of hardwood charcoal, either as a major product or a byproduct of distillation, has always offered important possibilities as an outlet for low-grade wood and the less preferred species. The industry has long been in an uncertain situation, so the Station made a survey to determine the present technical and economic status.

Market for distillation products other than charcoal is practically nonexistent. Consequently, the larger plants are switching to charcoal as a primary product. In addition, there is a good-sized group of charcoal producers who use small kilns of various kinds. Although it appears that the northeastern market for charcoal is generally adequate, there is little organized information on charcoal marketing. A thorough investigation of markets is needed to guide production interest.

Both large and small producers are having trouble marketing fines. A possible solution is to briquette this material. Although there are some developments in small briquetting outfits, there is need for further work. A very important problem is to find a cheap method of drying the formed briquettes. The Station aided developments in this field by supplying a machine manufacturer with Connecticut small-kiln charcoal for briquetting.

WOOD MOLASSES

Another possible use for utilization of low-grade wood has been for the production of molasses using the Madison wood-sugar process. With wood sugar molasses made by the Forest Products Laboratory (from eastern white pine) the State Agricultural Experiment Station of the University of New Hampshire, carried forward a series of 12 protein and energy digestive balance tests on dairy heifers.

These tests were designed to yield quantative measurement of the nutritive value of wood sugar, and information comparative with blackstrap molasses, its competitor. The over-all results of the carefully controlled experiments indicated that this material is suitable for and comparable to cane molasses as a feed for dairy cattle. The results of these tests were published in the "Journal of Dairy Science."

MECHANICAL PILING

It has long been realized that an important step in improving timber-conversion processes would be to eliminate seasoning losses. It is difficult to rationalize the generally poor treatment given green lumber once it is manufactured, particularly in small mills. Although there is little factual data on the economic losses resulting from poor seasoning, there is no question but that they are substantial

In recent years there has been introduced into the picture mechanical equipment which, primarily through saving in labor, has significantly reduced lumber-handling costs. However, there is reason to believe that such equipment has also created problems. Therefore the Station, in cooperation with the Forest Products Laboratory, studied 23 plants where such equipment is in use.

It found that where operating conditions were ideal, these machines can pile lumber in the manner equal to best hand piling. Under poor conditions, or where there has been a tendency toward sloppy piling, the use of the machine has not resulted in improvement. On the other hand, there is a need for a series of studies of piling methods with particular attention to the economics of the situation. Mechanical yard equipment can be handled to do any kind of piling desired. The problem is to develop piling specifications that will give greatest return on the investment.

KILN-DRYING STUDIES

Another phase of seasoning to which attention was directed is kiln-drying. Principles of modern dry-kiln practice have been developed by the Forest Products Laboratory. Regional practice, however, lags behind research knowledge. With the advice and guidance of the Station and the Forest Products Laboratory, the Forestry Department of the University of Maine has been carrying on experimental work with a small kiln on loan from the Laboratory.

Schedules for drying white birch and black gum bars and paper roll plugs have been developed. During the year additional improved schedules were set up for Brazilian rosewood, used by a handle manufacturer. Preliminary runs were made on refractory beech and on white pine. (For the latter, the object was to design a schedule to reduce brown stain.)

In the past the Station has helped the Forest Products Laboratory give a number of demonstration courses in kiln drying. Following these courses, three clubs for kiln-drying technicians were organized, one in Maine, one in the rest of New England and New York, and one in Pennsylvania. During the year the Northeastern Club met in Farmington, Maine, and there was combined meeting of the New England and Northeastern Clubs in Conway, N. H. Such meetings are valuable in that they give opportunity for operators to obtain newest technical information and interchange experience. The Station keeps in touch with these groups, attends their meetings, and sometimes helps to arrange programs.

PRESERVATIVE TREATMENTS

The protection of forest products from loss through decay and insects is another important utilization field. Throughout the Northeast, there are thousands of acres of red pine plantations now approaching or in the early stages of merchantability. To maintain growth, thinning is

essential. Such operations will yield a variety of products such as fence posts, flag poles, tobacco posts, and small saw-logs. For adequate service, pole and post material must be given preservative treatment.

To meet the need for a cheap treatment, a cooperative project with the Connecticut Forest Service was started late in 1948 and continued into 1949. This project used the sap-stream method of treating green material. One method for which working techniques were developed is the so called "stepping" method. Trees from thinnings are "stepped" into containers full of a water-soluble preservative. This moves through the tree in 40 to 72 hours.

Other treatments were made by immersing cut posts in barrels containing treating solution, and by placing dry salt (held in place by tire-tube sections) in post tops. In addition to the above with green material, tests were run to determine the possibilities of treating seasoned posts with an oil solution of pentachlorophenol by the cold-soaking method.

SUMMARY OF JOBS DURING 1949

Timber Conversion

Grades & Specifications

1. Studied applicability of log-grading system.
2. Participated in training schools for farm foresters.

Logging & Milling

1. Studied methods of improving power chain saws.
2. Tested "throw-away" bow-saw blades.
3. Studied Wyssen cableway system in Adirondacks.
4. Organized and conducted logging training school for experimental forest personnel.
5. Advised and assisted in Woodsmen field day in Adirondacks.
6. Prepared and published 14 papers, including one for national meeting of Forest Products Research Society (F.P.R.S.), United Nations' Conference on Conservation and Utilization of Natural Resources, and a Farmer's Bulletin, "Logging Farm Forest Crops in the Northeast."
7. Advised experimental forest personnel on logging equipment, operation, and marketing.
8. Studied new equipment, including automatic slab saws, West Virginia portable mill, sawdust briquetting machines.

Waste

1. Took part in conferences on bark utilization.
2. Helped in several projects, including Northeastern Wood Utilization Council and Federal Reserve Bank survey of wood waste, use of sawdust in smelting.
3. Studied wood as soil conditioner and took part in cooperative studies of chipping costs as affected by operating variables in Connecticut.

Wood Fuel

1. Completed tests of wood-burning furnaces.

Utilization

1. Helped organize and coordinate work of Northeastern Technical Committee on Utilization of Beech.
2. Studied product yields from red pine thinnings in Connecticut.

Seasoning

1. Surveyed mechanical handling of lumber for seasoning, in cooperation with Forest Products Laboratory.
2. Studied use of experimental dry kiln at University of Maine in drying rosewood, beech, and white pine.
3. Stimulated and guided activities of three dry-kiln clubs.

Wood Chemistry

1. Surveyed charcoal manufacture in Northeast in cooperation with Forest Products Laboratory.
2. Made preliminary cost and yield studies of operation of small Connecticut charcoal kiln.
3. Made nutritional studies of wood molasses with dairy cattle at University of New Hampshire.

Wood Preservation

1. Studied stepping, capping, and barrelling method of fence- and tobacco-post preservative in Connecticut, for green material.
2. Tested preservative treatment of seasoned fence posts in Connecticut, using oil-solution of pentachlorophenol.
3. Advised and guided a community vocational agriculture school on a fence-post treating program.

Pulp & Paper

1. Surveyed northeastern felt mills, in cooperation with Forest Products Laboratory.

General

1. Provided service to industry on technical problems, through plant visits and correspondence.
2. Advised Forest Product Laboratory in formulating research program.
3. Served as active member of Northeastern Wood Utilization Council.

Timber Conversion

Grades & Specification

1. Develop standard grades for tie and timber and local-use logs, sub-log material.
2. Develop commodity grades for specified products.
3. Hold at least two log-grade schools for National Forest personnel.
4. Prepare three papers on hardwood log-grades for F.P.R.S. meetings and University of Maine.

Logging & Milling

1. Study boltwood utilization practices.
2. Study operation of portable cut-off saw now in pilot manufacture.
3. Prepare note on Bishop sulky and other new equipment.
4. Prepare timber transportation data for SAF Foresters Field Manual.
5. Complete paper on integrated logging.

Waste

1. Make additional field tests of portable chippers to determine costs and returns.

Utilization

1. Beech project
   (a) Coordinate and aid others on preparation of 19 manuscripts, as required.
   (b) Prepare bulletins on beech supplies, logging, milling, turning of beech.
2. Prepare paper on planted red pine product yields.

Seasoning

1. Start work at University of Maine on brown stain in kiln-drying eastern white pine.
2. Work with Northeastern, New England, and Keystone Dry Kiln Clubs.

Wood Chemistry

1. Make census of charcoal kilns in Northeast.
2. Make test runs on small charcoal kilns.

3. Prepare article on charcoal production situation.
4. Try to arrange for tests of wood molasses at two universities, possibly three.

Timber Mechanics

1. Study mine timber problems.

Veneer & Plywood

1. Study northeastern veneer industry.

Wood preservation

1. Study further diffusion preservation methods by stepping, barrel treatment, and capping.
2. Test cold-soaking of red pine fence posts in pentachlorophenol-oil solution.
3. Study relation of heart and sapwood in plantation-grown red pine, as a lead to lowering treatment costs.

General

1. Provide service to industry on technical problems, through plant visits and correspondence.
2. Advise and guide in Forest Product Laboratory in formulating research program.
3. Serve as active member of Northeastern Wood Utilization Council.

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THE RESEARCH CENTERS
AND EXPERIMENTAL FORESTS AND WATERSHEDS
of the
NORTHEASTERN FOREST EXPERIMENT STATION

Under the authority of the McSweeney-McNary Act, the Forest Service conducts research in three broad fields: (1) forest, range, and watershed management, (2) forest-resource surveys, and (3) forest-products utilization. This research is being done at a National Forest Products Laboratory, at 11 regional experiment stations in the United States, at a station in Puerto Rico, and at a research center in southeast Alaska. The Northeastern Station is one of the 11 regional experiment stations.

Laboratory research on forest products is centered at the Forest Products Laboratory at Madison, Wis. Liaison with regional needs for research in wood utilization is aided by the Station's small Forest Utilization Service unit at Upper Darby.

Forest-resource surveys and related economic studies comprise a major activity at the Northeastern Station. This program requires the utmost mobility; so personnel are attached directly to the regional headquarters of the Station and work widely over the Northeast, with frequent changes of temporary headquarters in the field.

Regional research in forest and watershed management in the Northeast is conducted chiefly at a series of experimental forests and field laboratories. The major criterion in selecting an experimental forest, watershed, or other field laboratory is the extent to which it represents the problems of a regional type or problem area. In some cases more than one such experimental area is needed for adequate coverage of a regional type. Although the majority of research is concentrated on these experimental areas, some supplementary work in other conditions on outside lands is carried on.

To facilitate field operations, the work on one or more experimental areas and on nearby lands is usually directed through nearby offices known as research centers. These centers are convenient organizational devices that reduce travel costs and keep research personnel in intimate contact with their particular phases of a regional research project as well as with local cooperating agencies. Specialists located at the regional headquarters of the Station at Upper Darby participate in the research at the various centers and assist in the preparation of work plans and analyses of research results.

Following are the research centers and their locations, including the experimental forests and watersheds where the research is concentrated. The regional problem area or type is shown in parenthesis after the name of the research center. The locations of the experimental forests and field laboratories are shown on the map.

Penobscot (spruce-fir primarily, with admixture of hardwoods):
64 Coe Building, 15 Cross Street, Bangor, Maine.
1. Penobscot
2. Gale River

White Pine (white pine primarily, admixture of low-quality and weed hardwoods): Alfred, Maine.
3. Massabesic

Northern Hardwoods (northern hardwoods primarily, admixture of other types; critical watershed areas): Forest Service Building, Laconia, N.H.
4. Bartlett
5. Lawrence Hopkins Memorial

Adirondacks (spruce-fir and northern hardwoods, intermingled in small area, pure stands): Paul Smiths, N. Y.
6. Paul Smith
7. Finch-Pruyn

Allegheny Plateau (Allegheny hardwoods; critical watersheds): Upper Darby, Pa.
8. Kane

Anthracite (oak, with admixture of miscellaneous hardwoods and softwoods): Post Office Building, Kingston, Pa.
9. Pocono
10. Standing Stone

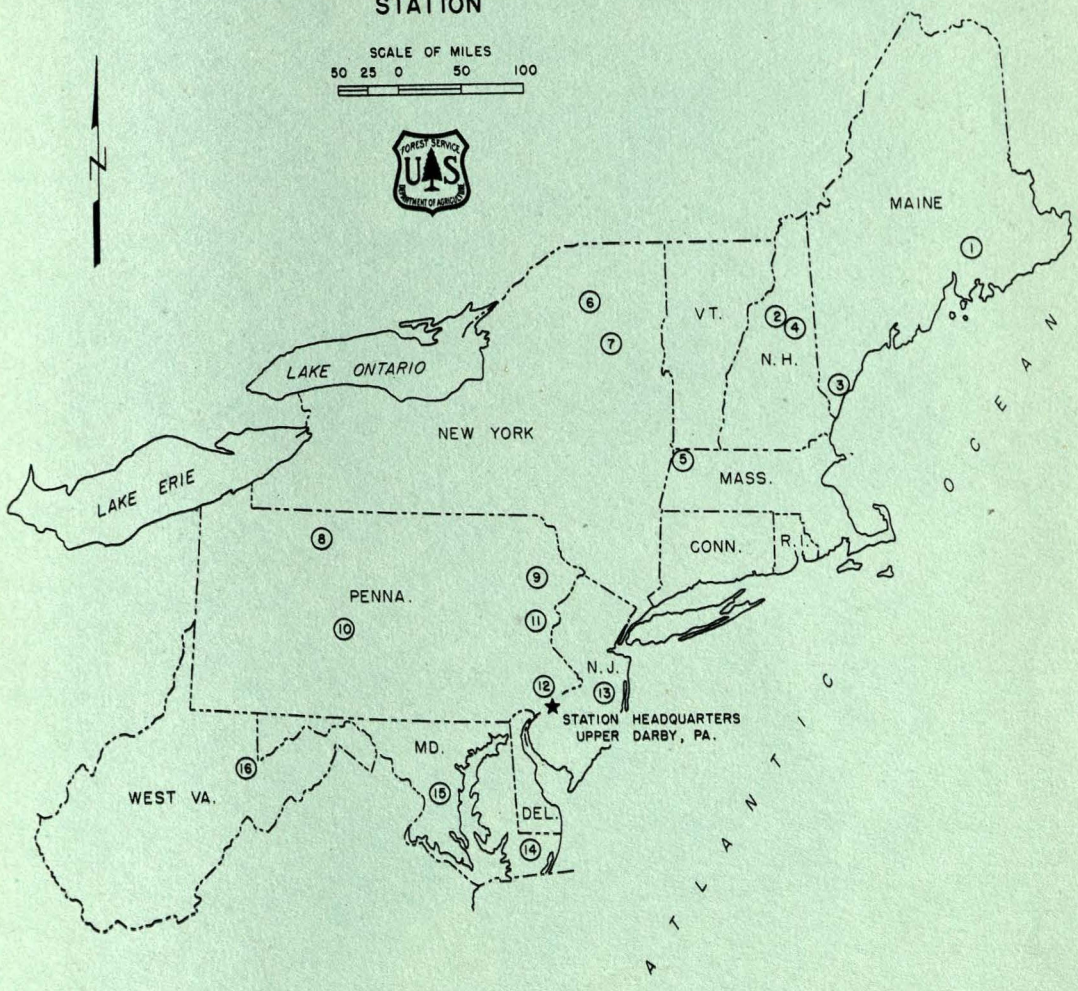
Delaware Basin (watershed of Delaware River): Williams Hall, Lehigh University, Bethlehem, Pa.
11. Delaware-Lehigh

Morris Arboretum (forest genetics work, primarily on hardwoods and national in scope): Upper Darby, Pa.
12. Morris Arboretum

Coastal Oak-Pine (oak-yellow pine, Virginia pine, Atlantic cedar): Upper Darby, Pa.
13. Lebanon
14. Eastern Shore
15. Beltsville

Mountain State (Appalachian hardwoods, cove hardwoods, chestnut oak, steep and critical watershed areas): Forest Service Building, Elkins, West Virginia.
16. Fernow

REGION SERVED BY THE NORTHEASTERN FOREST EXPERIMENT STATION



EXPERIMENTAL FORESTS AND FIELD LABORATORIES

1	PENOBSCOT	9	POCONO
2	GALE RIVER	10	STANDING STONE
3	MASSABESIC	11	DELAWARE-LEHIGH
4	BARTLETT	12	MORRIS ARBORETUM
5	HOPKINS	13	LEBANON
6	PAUL SMITH	14	EASTERN SHORE
7	FINCH-PRUYN	15	BELTSVILLE
8	KANE	16	FERNOW

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